

LOWER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody/Assessment Unit: Arkansas River below Hutchinson

Water Quality Impairment: Chloride

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Gar-Peace

Counties: Reno & Sedgwick

HUC 8: 11030010 and part of 11030011

Drainage Area: 1895 mi² between Nickerson and Hutchinson; 200 mi² between Hutchinson and Maize

Main Stem Segments: WQLS: 1, 3, 4 & 5; starting at confluence with Rattlesnake Creek and flowing downstream to confluence with Little Arkansas River

Tributary Segments: WQLS: Cow Creek (Segments 1 & 1755 of HUC 11030011)
Peace Creek (6)
Salt Creek (7)
Non-WQLS: Gar Creek (8)

Designated Uses: Aquatic Life Support; Primary Contact Recreation; Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use on Arkansas River and Cow Creek
Aquatic Life Support on Tributary Segments

1998 303(d) Listing: Table 1 - Predominant Point Source and Non-point Source Impact & Table 3 - Predominant Natural Sources

Impaired Use: Domestic Water Supply, Aquatic Life Support & Groundwater Recharge

Water Quality Standard: 250 mg/l for Domestic Water Supply (KAR 28-16-28e(c)(3)(A)) [At a point of domestic water supply diversion]

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the water quality criteria listed in Table 1a of subsection (d), at ambient flow, the existing water quality shall be maintained, and the newly established numeric criteria for domestic water supply shall be the background concentration, as defined in KAR 28-16-28b(e). Background concentrations shall be established using the methods outlined in the "Kansas implementation procedures: surface water quality standards," as defined in KAR 28-16-28b(ee).... (KAR 28-16-28e(c)(3)(B)).

860 mg/l for Aquatic Life Support [Acute criterion] (KAR 28-16-28e(c)(2)(F)(ii))

In surface waters designated for the groundwater recharge use, water quality shall be such that, at a minimum, degradation of groundwater quality does not occur. Degradation shall include any statistically significant increase in the concentration of any chemical or radiological contaminant...in groundwater resulting from surface water infiltration or injection. (KAR 28-16-28e(c)(6)).

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303(d): Not Supporting Groundwater Recharge

Monitoring Sites: Station 523 above Hutchinson, 524 below Hutchinson & 536 at Maize (Figure 1)

Period of Record Used: 1990 to 2002

Flow Record: 1970-2002 at Hutchinson (USGS Station 07143330); 1997-2002 at Nickerson (USGS Station 07142680); and 1987-2002 at Maize (USGS Station 07143375) (Figure 1)

Long Term Flow Conditions at Hutchinson: Mean Flow: 540 cfs; Median Flow: 265 cfs; Upper Quartile: 146 cfs; Upper Decile: 91 cfs; Upper Percentile: 48 cfs.

Arkansas River Hydrology: Flow has been sustained along the Arkansas River below the confluence of Rattlesnake Creek since flow records began at Hutchinson in 1960. This maintenance of flow is likely influenced by the contributions of natural mineral intrusion from the south tributaries and underlying ground water which effectively limits the consumption of water for beneficial uses. There has tended to be a gain in flow between the gaging stations at Nickerson and Hutchinson. This gain in flow is attributed to Salt and Cow Creeks, ground water contributions and point source discharges in and around Hutchinson. Table 1 summarizes flows at varying conditions over various periods of record. Table 2 shows the number of years that average low flows over specified days were below certain levels. Low flows of concern to this TMDLs are below 100 cfs and occurred over a month nearly once every three years, on average. Critical low flows below 50 cfs over one or two weeks occurred roughly once every eight years, on average. Therefore, there is a high likelihood of encountering low flow conditions when the impact of point sources and the loss of water is significant.

Over the 15 years (1988-2002) of concurrent record between Hutchinson and Maize, gains in flow occurred when the 200 square miles of intervening drainage between the stations contributed runoff. As conditions become more dry, represented by flows exceeded 75% of the time or more, there is a marked loss of flow in the downstream direction. Studies by USGS along the Arkansas River in the vicinity of the Equus Beds aquifer have shown a gradient of flow moving from stream into the surrounding aquifer near Maize. This loss of flow from the river is likely caused by regional drawdowns from the extensive withdrawals from irrigation and municipal wells in the Equus Beds.

Arkansas River near Hutchinson

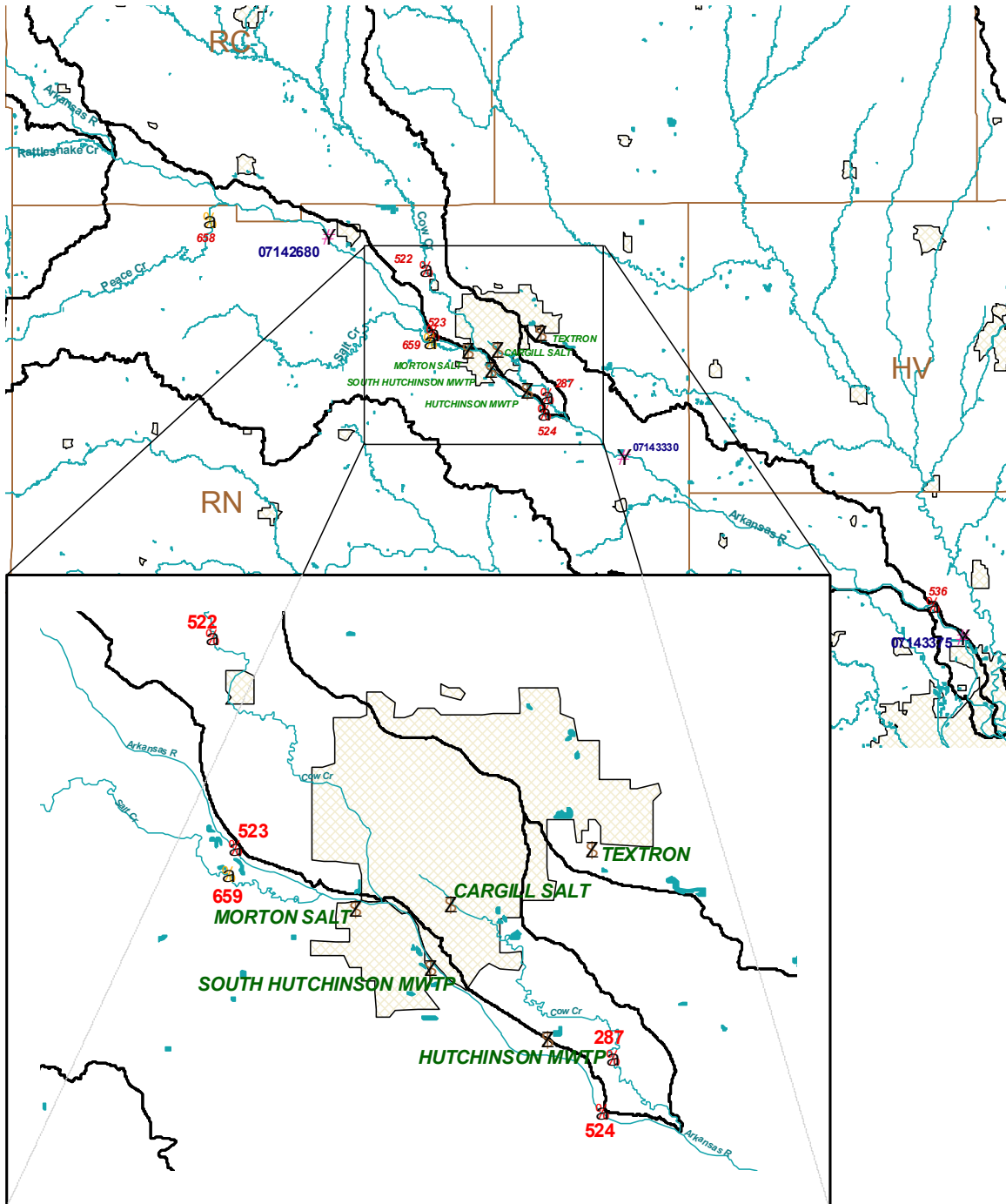


Figure 1. Base Map of Arkansas River in Vicinity of Hutchinson.

Table 1: Flow Statistics for Arkansas River Stations, Using Comparable Periods of Record

	Hutchinson	Hutchinson	Maize	Hutchinson	Maize	Nickerson
Flow	1970-2002	1987-2002	1987-2002	<i>1997-2002</i>	<i>1997-2002</i>	<i>1997-2002</i>
Mean Flow	540 cfs	574 cfs	736 cfs	<i>697 cfs</i>	<i>908 cfs</i>	<i>477 cfs</i>
Median (50%)	265 cfs	285 cfs	307 cfs	<i>473 cfs</i>	<i>513 cfs</i>	<i>328 cfs</i>
Quartile (75%)	146 cfs	143 cfs	138 cfs	<i>314 cfs</i>	<i>348 cfs</i>	<i>206 cfs</i>
Decile (90%)	91 cfs	87 cfs	66 cfs	<i>188 cfs</i>	<i>208 cfs</i>	<i>104 cfs</i>
95%	71 cfs	68 cfs	50 cfs	<i>153 cfs</i>	<i>145 cfs</i>	<i>88 cfs</i>
99%	48 cfs	45 cfs	13 cfs	<i>110 cfs</i>	<i>73 cfs</i>	<i>76 cfs</i>

Table 2. Selected Average Low Flows on Arkansas River near Hutchinson, 1960-2002

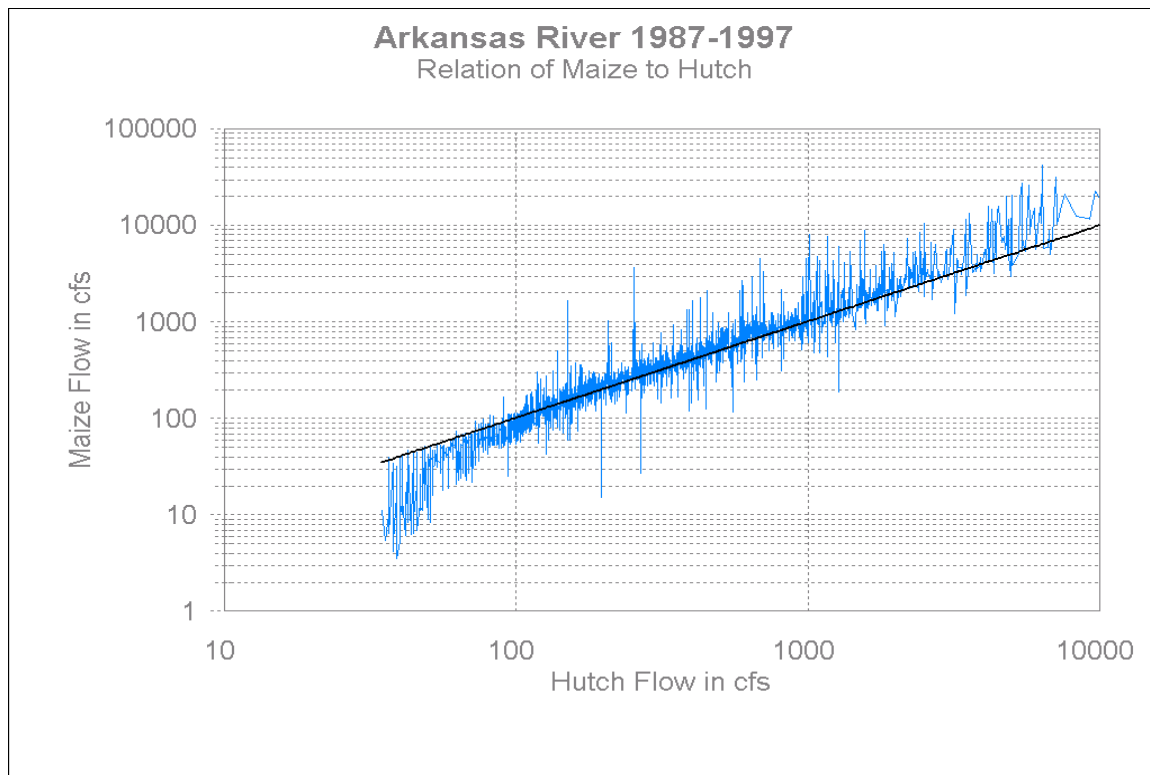
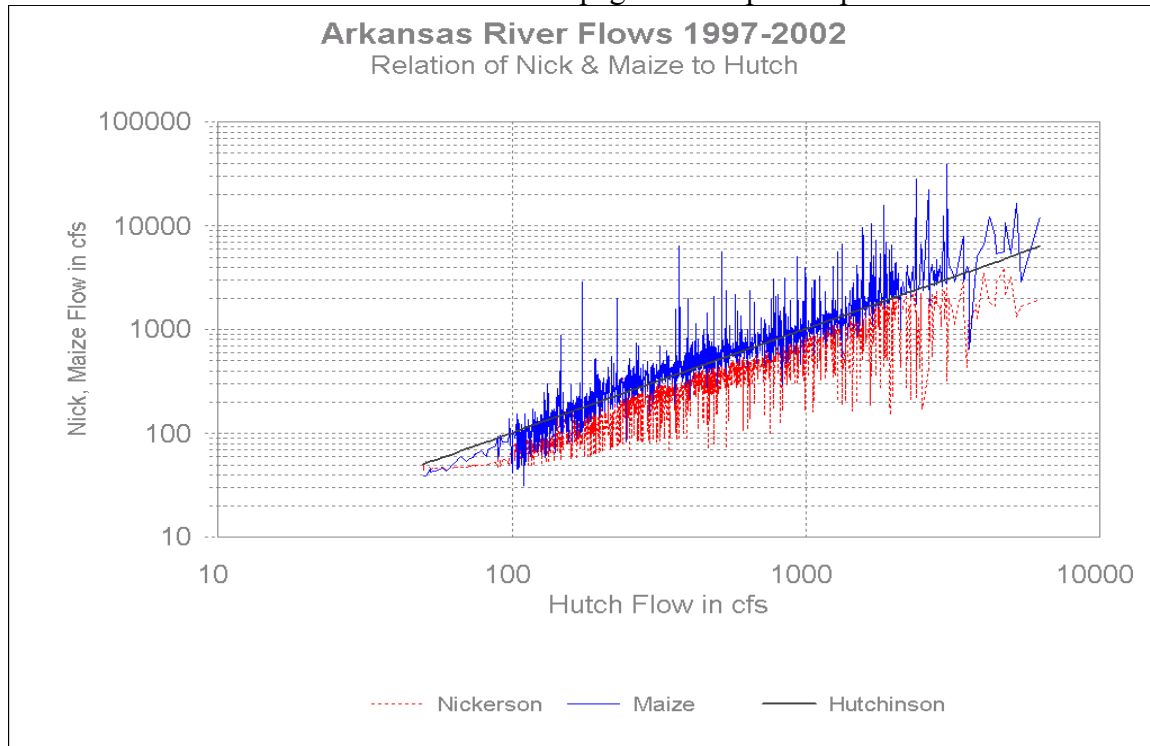
Average low flow	Over 7 days	Over 14 days	Over 30 days	Over 60 days
Flow < 100 cfs	20 years	18 years	15 years	11 years
Flow < 75 cfs	12 years	12 years	11 years	5 years
Flow < 50 cfs	5 years	5 years	3 years	2 years

Figure 2 shows the relationships among daily flows at Nickerson, Hutchinson and Maize over 1997-2002, using Hutchinson as the comparison base. There is a predominant pattern of flow gain between Nickerson and Hutchinson. Second, there is gain in flow between Hutchinson and Maize at higher flows. Finally and most significantly, at flows below 100 cfs, there is a predominant loss of water between Hutchinson and Maize. Figure 3 verifies this losing relation over the 15 years of concurrent record between the two stations. This loss of flow in the downstream direction, combined with the conservative nature of dissolved chloride suggests there is a loss of chloride mass into the surrounding freshwater aquifer. The potential degradation of the freshwater within the Equus Beds by chloride in the river represents the primary concern of this TMDL.

Figure 4 shows the respective flow duration curves for the gaging stations at Hutchinson and Maize and confirms the long term loss of water at lower flows which are exceeded 75-99% of the time. The most severe loss is under the critical low flows, such as the 7Q10, where 75-80 percent of the flow seen at Hutchinson is lost prior to gaging at Maize. As flows increase, the proportional loss of flow decreases to roughly 25 percent. Figure 5 displays a time period where severe loss of flow is encountered between the two stations. The drought of 1991 was severe along the Arkansas River, particularly in October when the lowest flows in the period of record were seen at Maize.

Dodge City Flows: Another influence on flow conditions in the Hutchinson vicinity is the input of water originating from the drainage areas of Western Kansas and Colorado. Typically, flow in

the Arkansas River is lost to channel bed seepage and evapotranspiration between Garden City



Figures 2 and 3. Relationship between Flow at Nickerson, Hutchinson and Maize

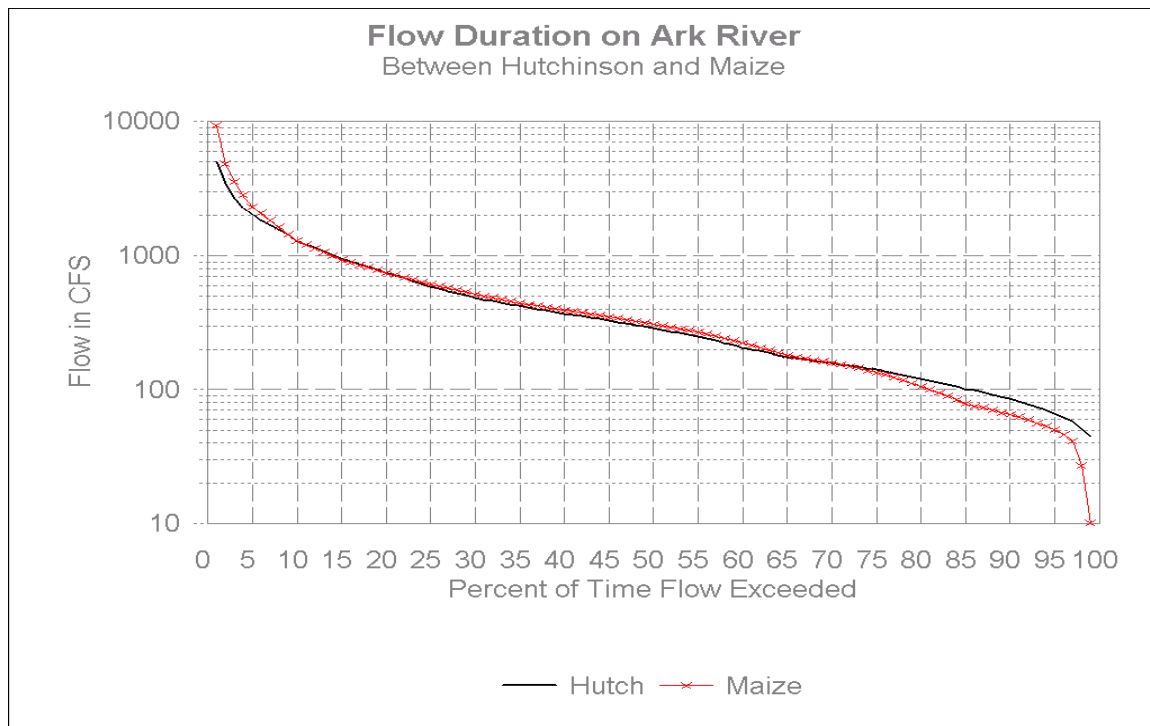


Figure 4. Flow Duration at Hutchinson and Maize Stations on Arkansas River

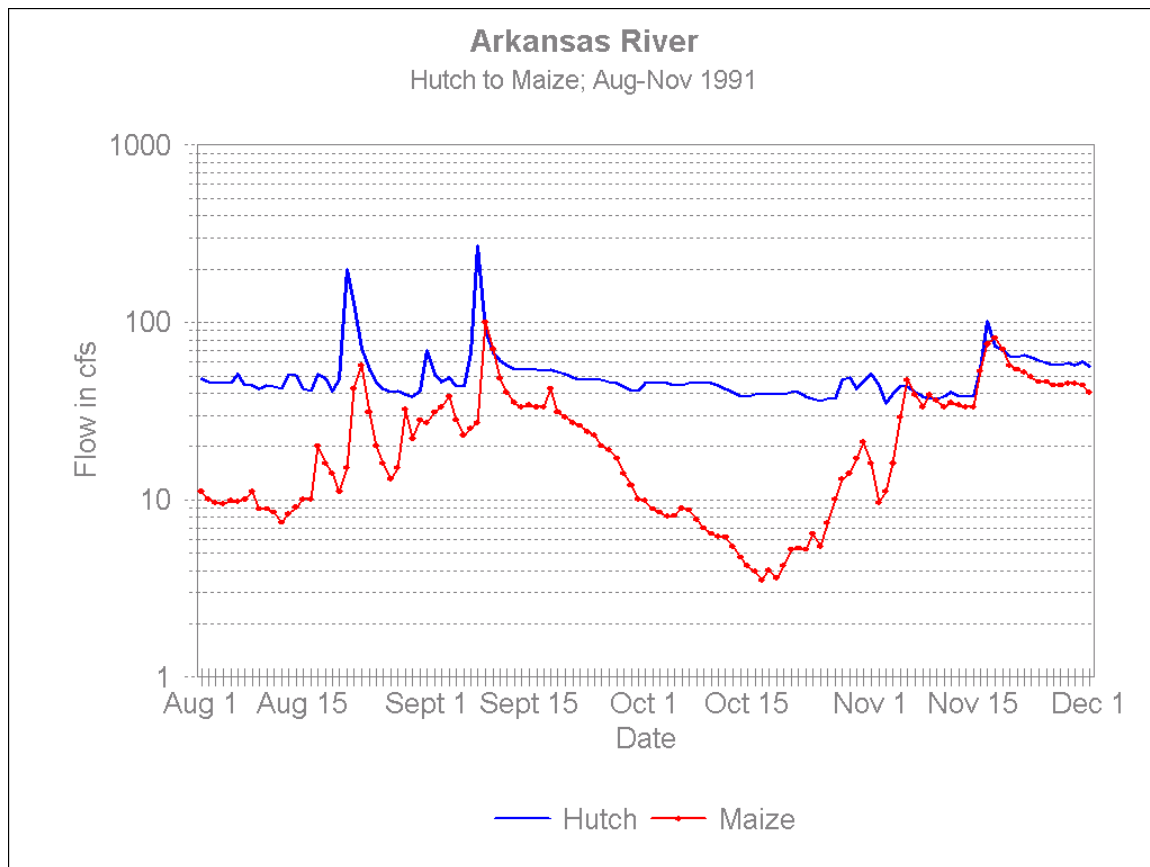
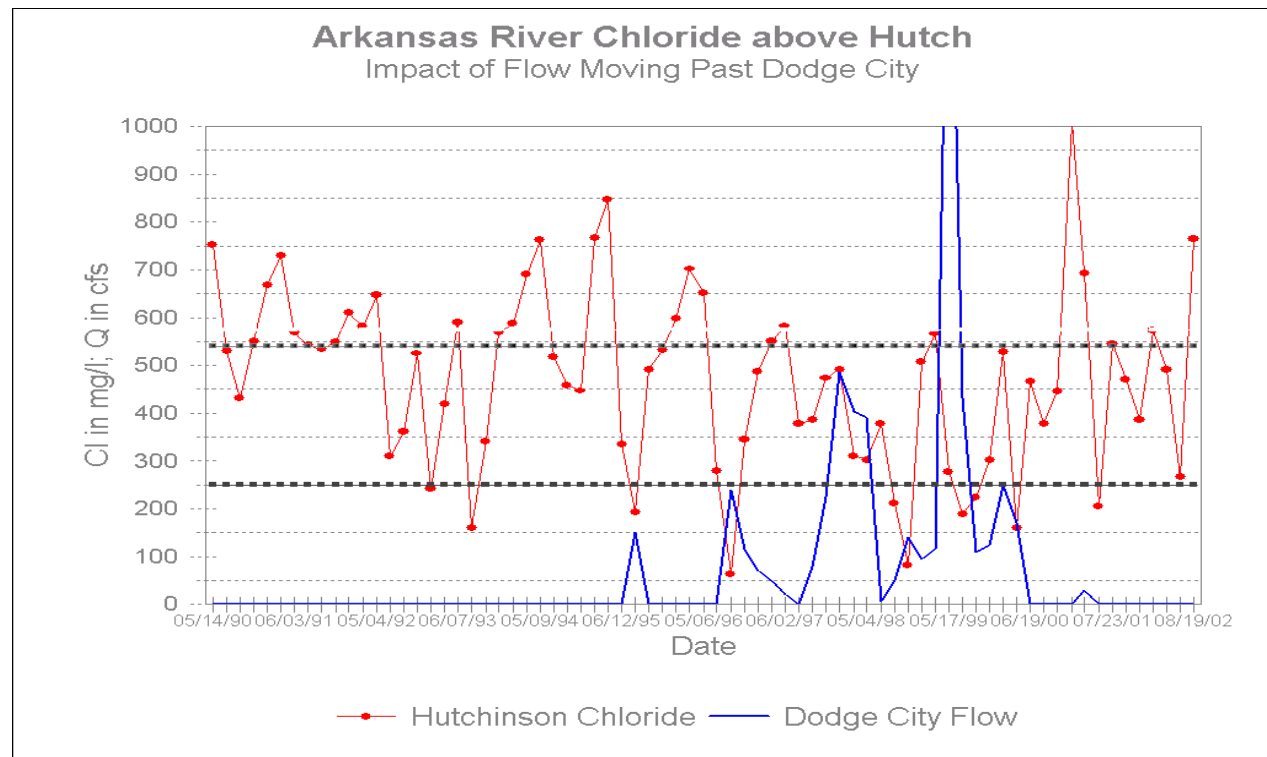


Figure 5. Flow Conditions on Arkansas River at Hutchinson and Maize in Fall, 1991

and Dodge City. The flow record at Dodge City is predominately zero daily flows over 1988-1996. Weather conditions over the basin turned more favorable in mid-1996 and flow resumed past Dodge City beginning in June 1996. This flow from the Colorado stateline to the Oklahoma stateline marked a wet period which ended in June 2000. Thereafter, dry conditions again saw little flow moving past Dodge City. Figure 6 illustrates the alteration in flow conditions between the dry period of 1988-1996 and wet period of 1986-2000 along the Arkansas River from Dodge City to Maize. Under dry conditions, the river basically starts anew at Great Bend and increases in flow once the high chloride waters from Rattlesnake Creek enter the Arkansas River above Hutchinson. The loss of water between Hutchinson and Maize is a persistent feature at flows exceeded 75% of the time or more, regardless if conditions are wet or dry. The significance of the movement of water past Dodge City to the Hutchinson area is Arkansas River water from western Kansas and Colorado is low in chloride content, and sulfate is the dominant salt. Therefore, during the wet periods, the sulfate levels in the river around Hutchinson rise dramatically, while the chloride concentrations are diluted. Coincidentally, the periods when there is a noticeable increase in chlorides below the city coincide with conditions when the river does not flow past Dodge City. Therefore, the dilution base for the river is eliminated and the background levels of chloride are high.

Figure 6. Impact of Dodge City Flows on Hutchinson Chloride Levels



Cow Creek: Cow Creek flows from Rice County, moving southeasterly past the community of Willowbrook, before entering Hutchinson. Prior to entering the city, there is a diversion canal and flood control structure which directs most of the flow to the south, where it enters the Arkansas River. There is a gate control structure at the point where the natural channel is intersected by the diversion canal. This gate allows a portion of the Cow Creek flow to enter the

city. This remaining flow is again intercepted by the Harsha Canal which moves some of the water to the Arkansas River, prior to the original channel entering downtown Hutchinson. East of downtown, the original channel carries water southeasterly toward the Arkansas River. A number of small industries discharge to the original channel as does Cargill Salt. The GVI ditch moves water from the northeast industrial park area surrounding the Hutchinson Municipal Airport and delivers it south to Cow Creek. A ground water remediation project at the Cessna-Eaton site discharges water from its air stripping operation to the GVI ditch. There are no flow measurement stations on Cow Creek within the city. Therefore, flow relations will have to be estimated from conditions on the Arkansas River below Hutchinson.

Arkansas River Chloride Concentrations: Samples have been taken along the Arkansas River since 1990. Overall, concentrations have remained above the desired criterion of 250 mg/l throughout the period of record at all stations. Station 523, located above Hutchinson, shows a trend of increasing concentrations at lower flows (Figure 7). Table 3 displays the average chloride concentrations and the upper 90% confidence interval bound of those means under various flow conditions at all three stations along the Arkansas River.

There is no significant difference in chloride concentrations among the three stations within the overall period of record, nor in datasets delineated by flows exceeded 50% of the time (Figure 8). Figures 9 and 10 demonstrate this finding in profiling chloride concentrations on both sides of the Arkansas River as it traverses Hutchinson. These profiles, taken by the Kansas Geological Survey in March and July of 2002 show the impact of point source discharges, notably, in elevating the chloride levels along the south side of the river (Whitemore, 2002). However, within a short distance downstream, the river mixes completely and the profile returns to its concentration level seen prior to entering the city.

Table 3: Average Chloride Concentrations Along Arkansas River with 90% Upper Bounds for Means

Flows/Station	Station 523	Station 524	Station 536	Sample Size
Complete Data	474-502 mg/l	462-489 mg/l	436-462 mg/l	73
Exceeded 50% of time	551-585 mg/l	563-594 mg/l	534-560 mg/l	34
Exceeded 75% of time	564-595 mg/l	617-644 mg/l	572-609 mg/l	17
Exceeded 90% of time	577-604 mg/l	645-670 mg/l	642-672 mg/l	6
Less than 100 cfs	560-595 mg/l	628-659 mg/l	614-646 mg/l	9
August-October, 1991 (45 cfs))	534-542 mg/l	623-666 mg/l	627-692 mg/l	2

The flow in the river in March was 130 cfs and 115 cfs in July. These flows have been exceeded between 75-80 % of the time. While there is a slightly significant difference in chloride concentrations between Stations 523 and 524 below flows exceeded 75% of the time, it would appear that strongly significant differences occur at the lower flows, typically below 100 cfs, exceeded 85% of the time, where there is a notable increase in chloride concentrations at Station 524 downstream from Hutchinson (Figure 11). Point source discharges influence the water quality of the river at low flows, approaching the 7Q10 flow value used for wastewater design.

Figure 7: Chloride at Station 523 under Varied Flow Conditions

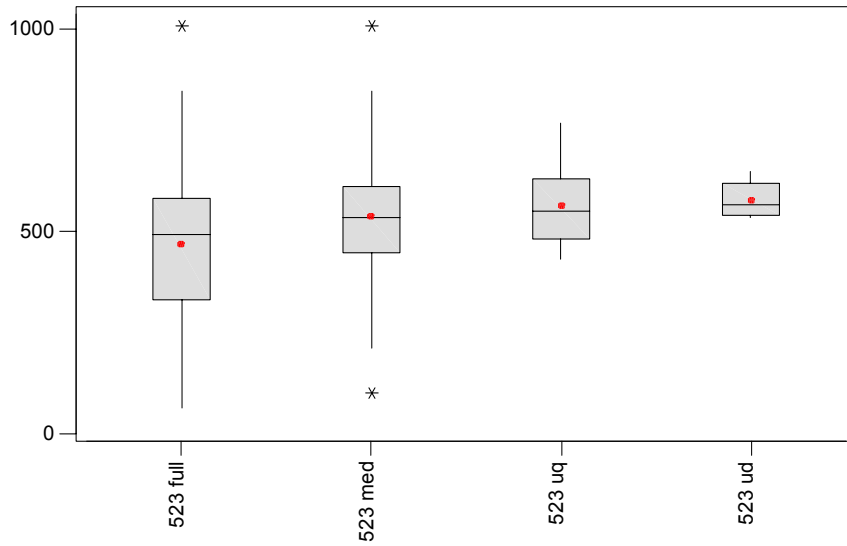
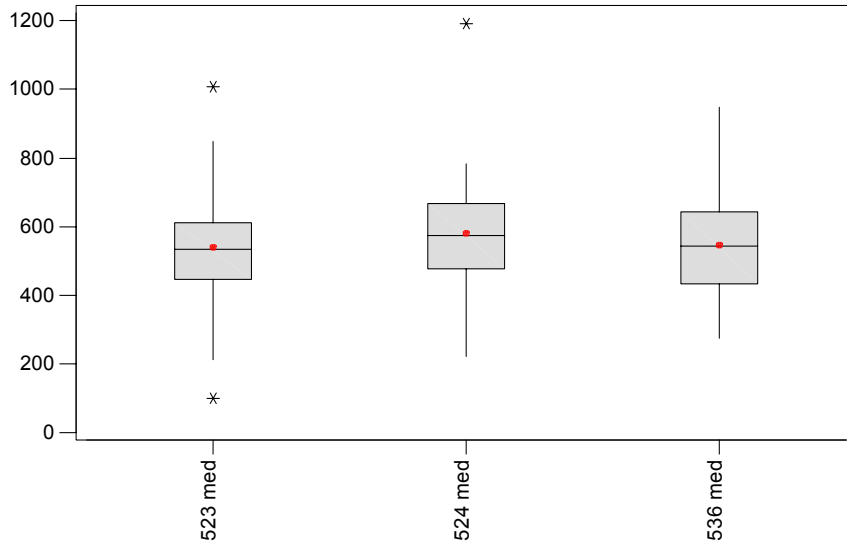


Figure 8: Chloride Along Arkansas River under Median Flow Conditions



Note: Full means all flow conditions; med means flows below median flow; uq means flows below 75% exceedance and ud means flows below 90% exceedance.

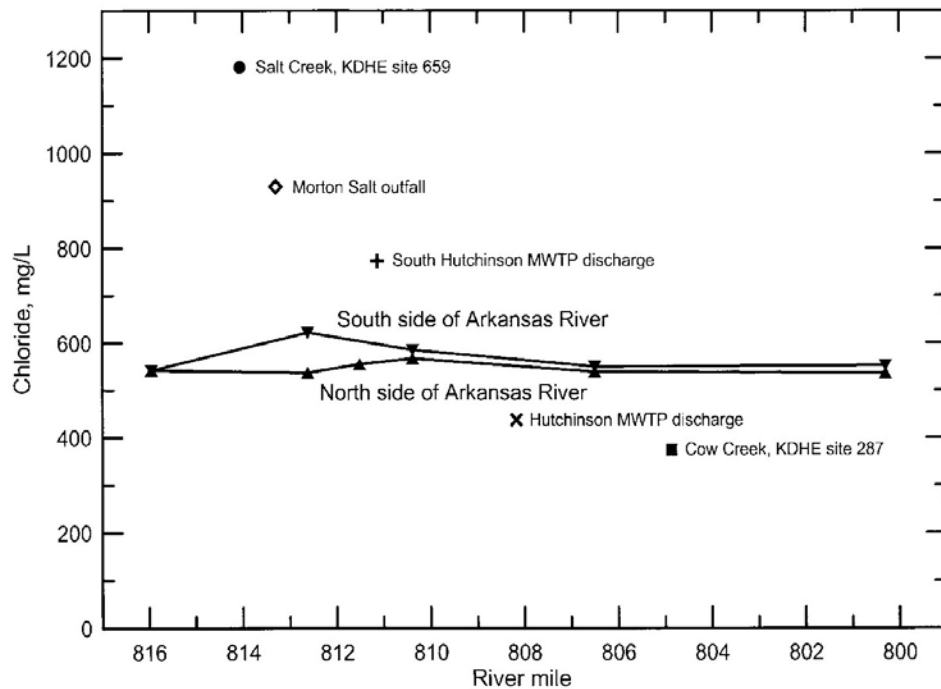


Figure 9. Profile of chloride concentration along the Arkansas River in the Hutchinson area for March 12, 2002.
(Whittemore, 2002)

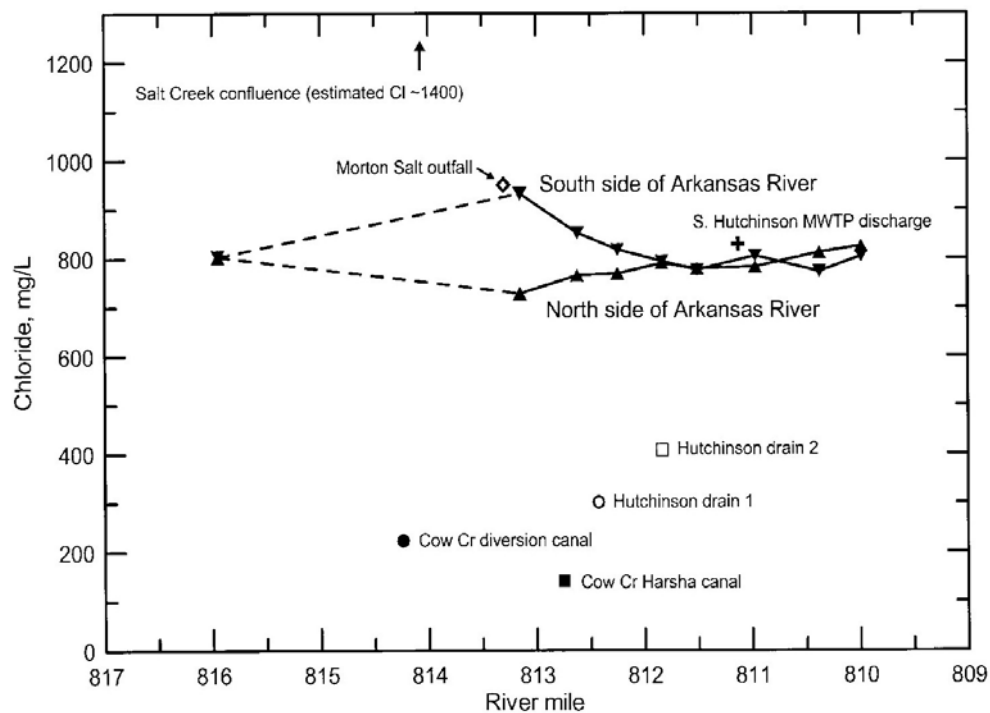
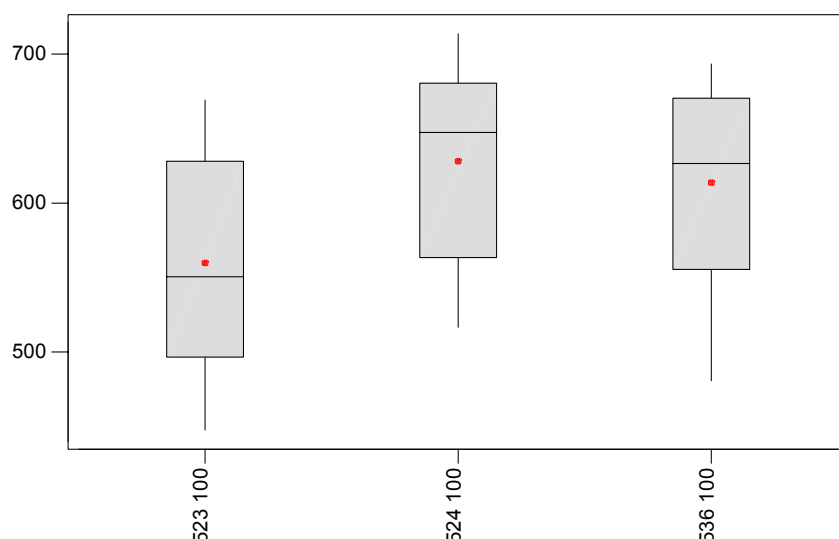


Figure 10. Profile of chloride concentration along the Arkansas River in the Hutchinson area for July 15, 2002.
(Whittemore, 2002)

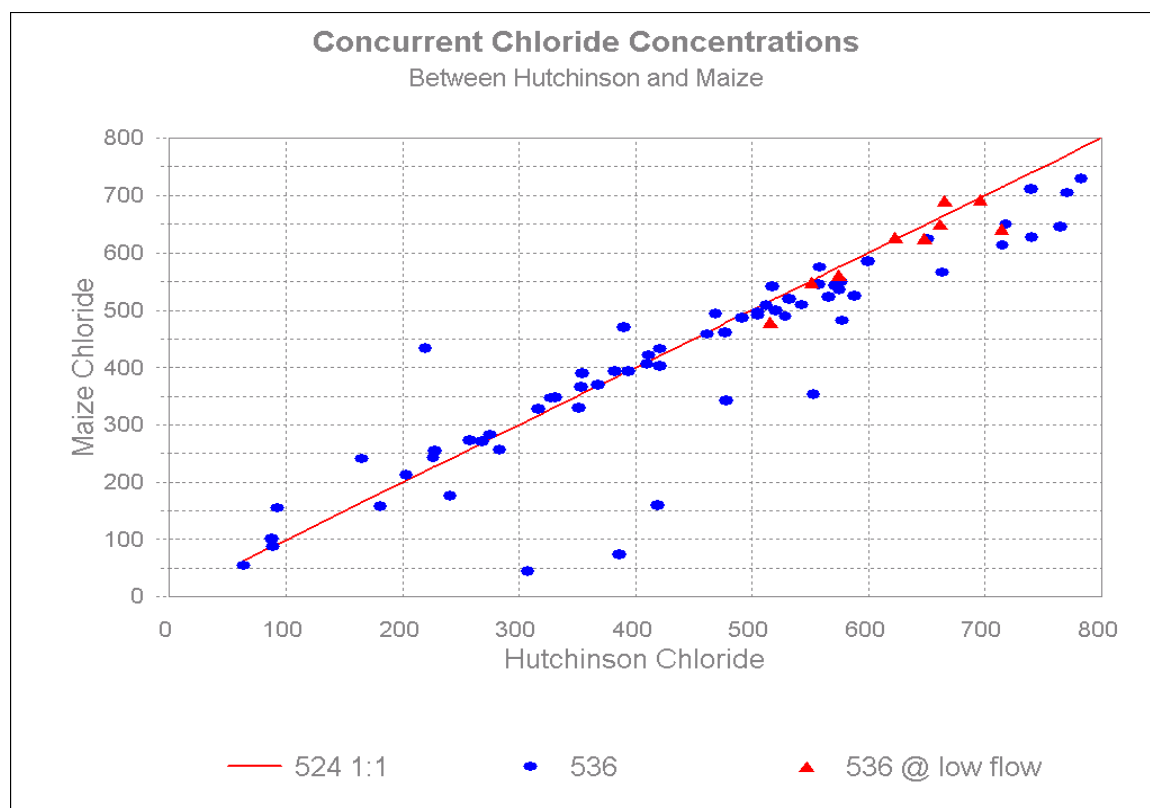
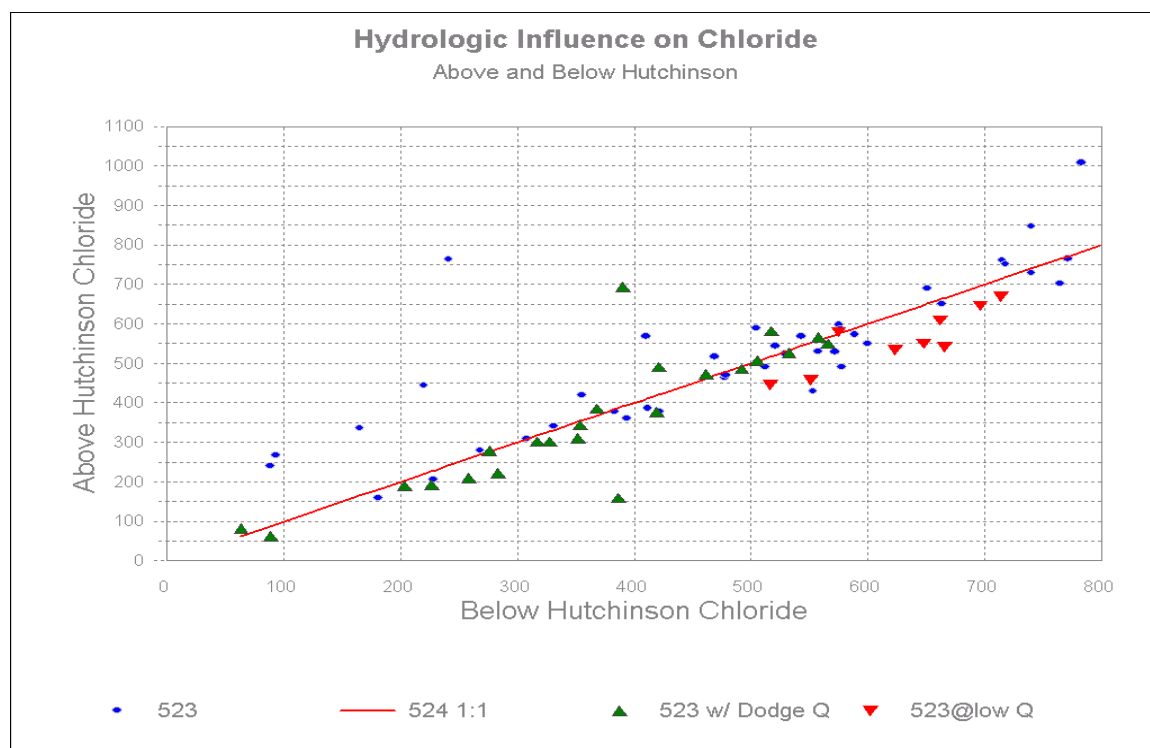
Figure 11: Chloride at Ark R. Stations at Flows below 100 cfs



calculations. A number of the wastewater dischargers in the Hutchinson vicinity have elevated chlorides that will increase the river concentrations for longer distances than that seen in Figures 9 and 10 during higher flows.

Figure 12 illustrates the relationship in chloride levels between the stations upstream and downstream of Hutchinson. With a few anomalies among the concurrent samples taken at Stations 523 and 524, most of the samples align along the 1:1 line using Station 524 as its base. There are two features to notice in the figure. First, samples which were collected during periods when flow was moving past Dodge City (triangles) line up very close to the 1:1 line, suggesting that the river conditions prior to reaching Hutchinson, will dictate the chloride concentrations seen above and below the city. A majority of these plots lie below 550 mg/l at Station 524. The second feature is the pattern of deviation from the 1:1 line in the area demarcated from 550-700 mg/l at Station 524 (inverted triangles). These samples were taken when there was less than 100 cfs of flow at the Hutchinson gage. The distance of deviation for these samples suggests a pattern of increased river chloride concentration once the river was past the city. These samples occur at the lowest flows among the samples with no flow contributions from the west and pervasive drought conditions. Seven of the nine samples were taken during the 1991-92 drought. These conditions of noticeably increased chloride levels coincide with periods of substantial loss of flow from the Arkansas River into the downstream Equus Beds. As such, these conditions will be the focal point of this TMDL.

There is no significant difference in chloride levels between Stations 524 and 536. Since there is only 200 square miles of drainage and no point source discharges, it stands to reason that there is little alteration in the chloride content in the river by dilution or loading. Figure 13 shows concurrent sampling below Hutchinson and at Maize. There is little deviation from the 1:1 line for a majority of the samples. The key pattern to notice is samples over 500 mg/l at Station 524. There is a general pattern of dilution seen at the downstream station, but exceptions are seen as



Figures 12 and 13. Concurrent Chloride Sampling on Arkansas River.

the triangle plots which occur during flows below 100 cfs. Those exceptions show no reduction in chloride between the two stations. This observation means that, in the face of water loss between the two stations, the cause of the loss is seepage into the surrounding aquifer, rather than evaporation. If evaporation was the primary loss mechanism, the concentrations seen at Station 536 would be higher than upstream at Station 524 as the water vaporized and left the chloride behind. The realization that the concentrations are unchanged between the two stations during the critical low flow conditions means the chloride is going with the water as it is induced into the underlying ground water.

Cow Creek Chloride Concentrations: There are two stations which bracket Hutchinson on Cow Creek. Station 522, near Willowbrook, has the lowest chloride levels of any station in the Hutchinson vicinity. Station 287 is located east of Hutchinson and has chloride levels similar to those seen on the Arkansas River. Table 4 displays the average chloride concentrations and 90% upper confidence limit for both stations under presumed low flow conditions.

As dry conditions lower flows, the average concentrations of chloride at Station 522 increase (Figure 14). The rate of increase on the lower reaches of Cow Creek monitored by Station 287 is even greater under lower flow conditions (Figure 15). This observation probably reflects the diminishment of relative freshwater entering from the Willowbrook area and a higher proportion of the flow seen at Station 287 comprising wastewater discharges, some of which have elevated chlorides. Across the board, there is a significant difference among the mean chloride levels of the two stations (Figure 16). Plotting concurrent samples clearly indicates increased chlorides at the downstream sites (Figure 17).

Table 4. Average Chloride Concentrations Along Cow Creek with 90% Upper Bounds for Means

Flow/Station	Station 522	Station 287	Sample Size
Complete Record	252-266 mg/l	414-433 mg/l	76
Exceeded 50% of time	274-291 mg/l	445-474 mg/l	39
Exceeded 75% of time	299-324 mg/l	518-554 mg/l	18
Exceeded 90% of time	297-343 mg/l	608-649 mg/l	6

Figure 14: Chloride at Station 522 under Varied Flow Conditions

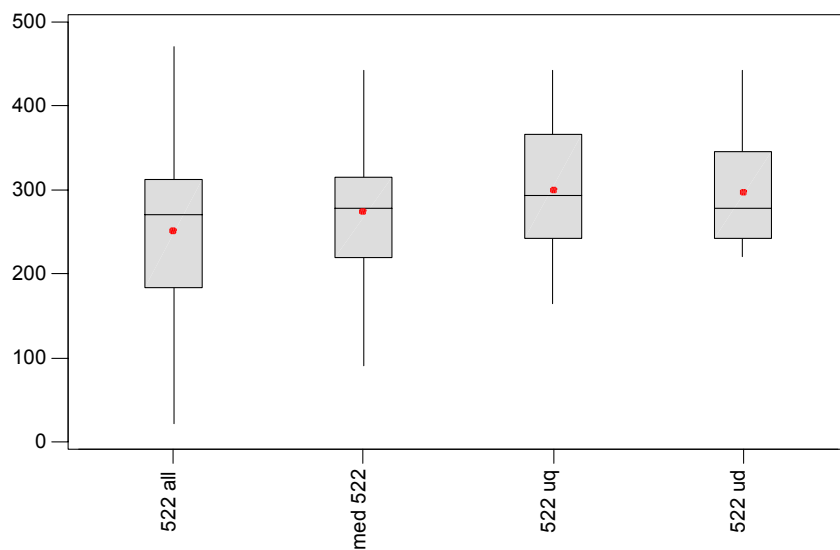


Figure 15: Chloride at Station 287 under Varied Flow Conditions

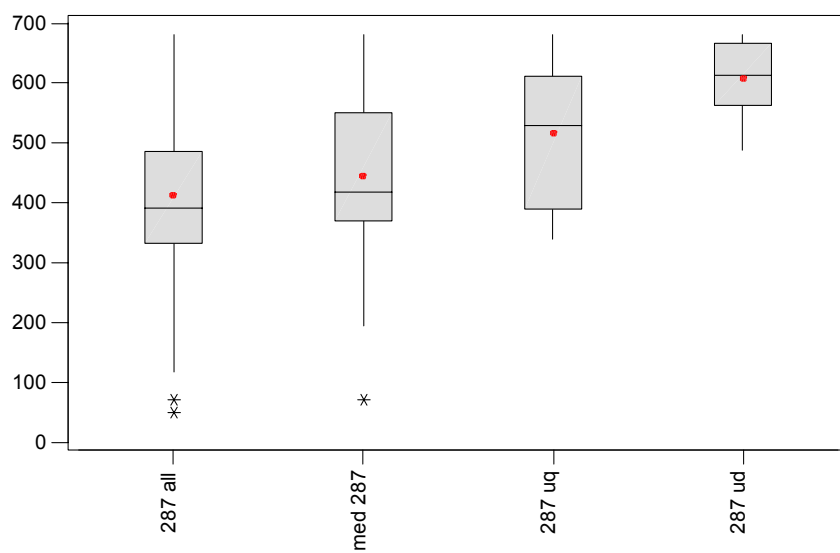


Figure 16: Comparison of Average Chloride at Lower Cow Creek Stations

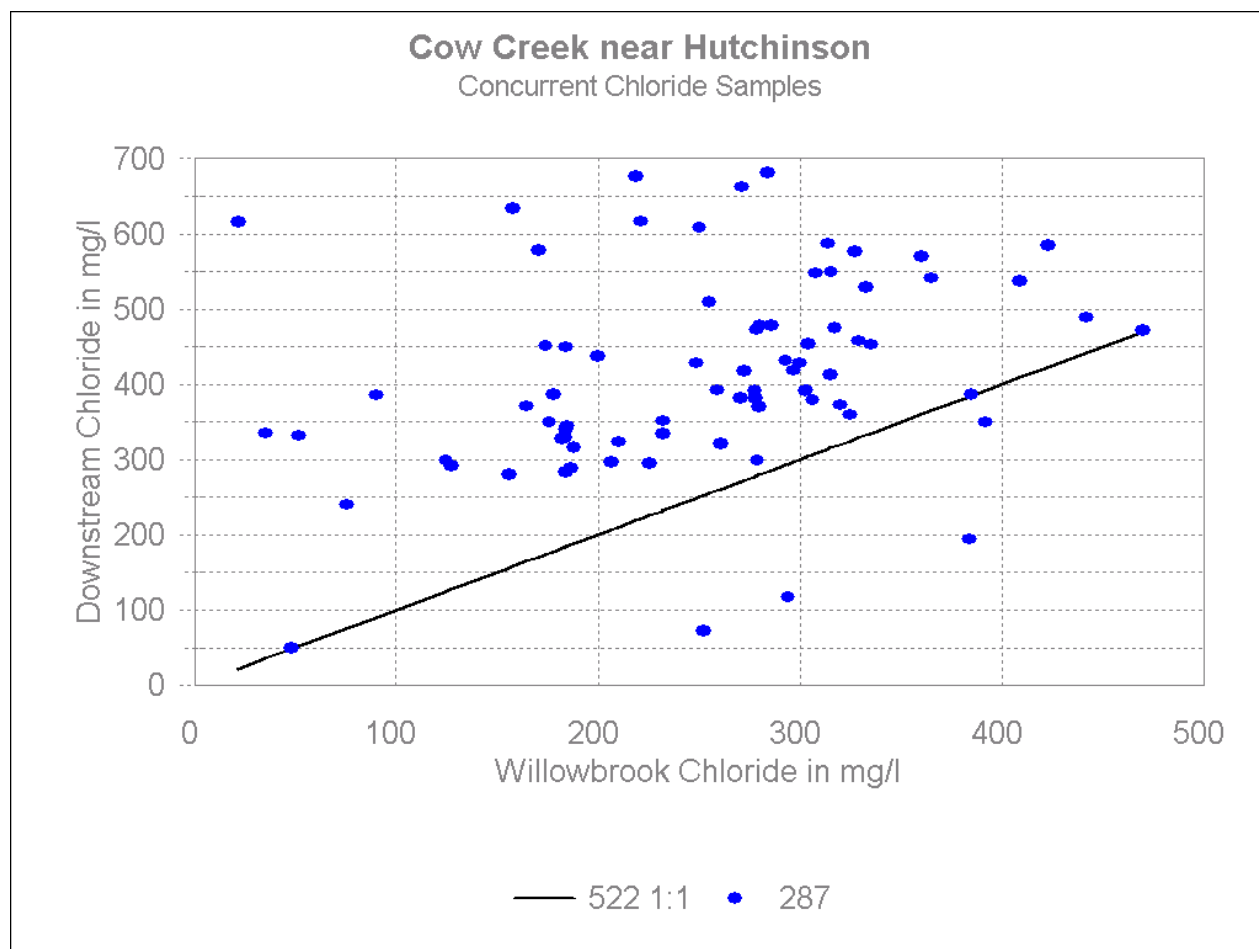
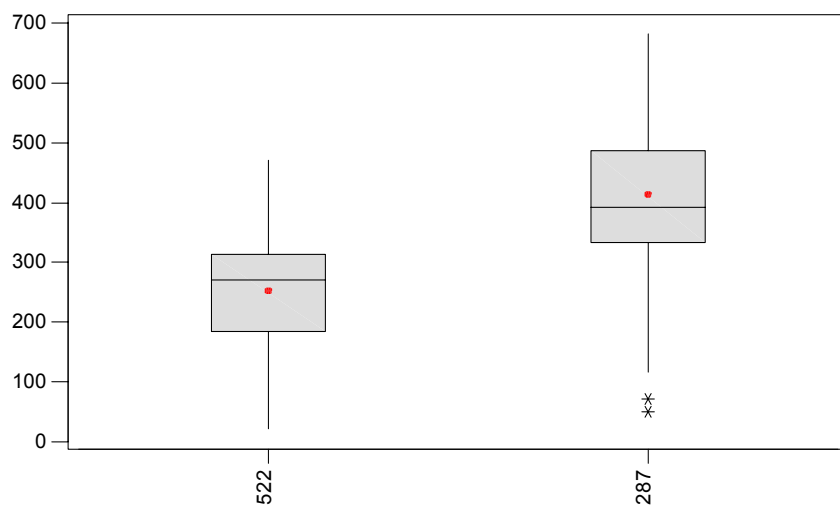


Figure 17. Concurrent Samples Collected on Lower Portions of Cow Creek near Hutchinson

A series of samples were taken by the Reno County Local Environmental Protection Program in 2000. Figure 18 shows the average chloride concentration for selected sites, for periods which were not influenced by rain or runoff. The uppermost site coincides with the KDHE Station 522. The Hendricks site is on the original channel after the flood control diversion gate. The Poplar site is along the an open channel near downtown. The Severance site is downstream from downtown and the Cargill plant. The Illinois site is located at the junction of the GVI ditch and Cow Creek. The Yoder site is immediately upstream of KDHE Station 287. It is apparent from Figure 18 that water quality was below 250 mg/l on Cow Creek flowing into the downtown area. With the reception of wastewater from Cargill along Cow Creek and the Cessna-Eaton (now Textron) remediation project via the GVI ditch, the downstream stations are elevated by 100 - 200 mg/l of chloride over the upstream levels.

Desired Endpoints of Water Quality at Arkansas River and Cow Creek Stations after 2008

The endpoint of this TMDL will be to achieve the Kansas Water Quality Standards to fully support the designated uses on the Arkansas River and Cow Creek. However, attainment of the 250 mg/l criterion for Domestic Water Supply is not possible for the Arkansas River because of the elevated background concentration and the lack of any points of diversion where the standard is applied. This TMDL will establish those background concentrations and use them as the endpoints for subsequent assessment of the Domestic Water Supply and Aquatic Life Support Uses.

Because of the variability of chloride concentrations seen at the upstream stations 522 and 523, which represent natural conditions, not impacted by anthropogenic discharges, the background concentrations will be expressed as a range of values. The lower value will be defined as the average concentration for samples taken during flows that are less than median flow. The upper value is defined by the upper 90 percent confidence bound around the average concentration for samples taken at flows exceeded 90% of the time or more. These background concentrations shall be applied at the downstream stations 287 and 524 for water quality evaluation and assessment. In order to achieve these endpoints, average concentrations over 5-6 years at the two downstream stations should fall within or below the indicated ranges. Table 5 displays the desired endpoints for the Arkansas River and Cow Creek for this chloride TMDL

Table 5. Desired Endpoints for Chloride Concentrations for Arkansas River and Cow Creek

Limit / Stream	Arkansas River @ Station 524	Cow Creek @ Station 287
Lower Limit	550 mg/l	275 mg/l
Upper Limit	595 mg/l	340 mg/l

Additionally, there is the designated use of Groundwater Recharge, which is the primary concern for this TMDL because of the significance of the Equus Beds as a regional water supply. Figure 19 provides estimates of the amount of chloride mass lost to the Equus Beds from the Arkansas River under varying low flow conditions. At the critical low flow, almost 80% of the flow is lost to the aquifer. Since there is no difference between concentrations seen at Stations 524 and 536, the amount of chloride mass lost, assuming a concentration of 660 mg/l, is over 60 tons per day. The percentage loss and the amount of mass lost drop off considerably with higher flow conditions. At a flow of about 100 cfs, the average concentration is about 600 mg/l, the

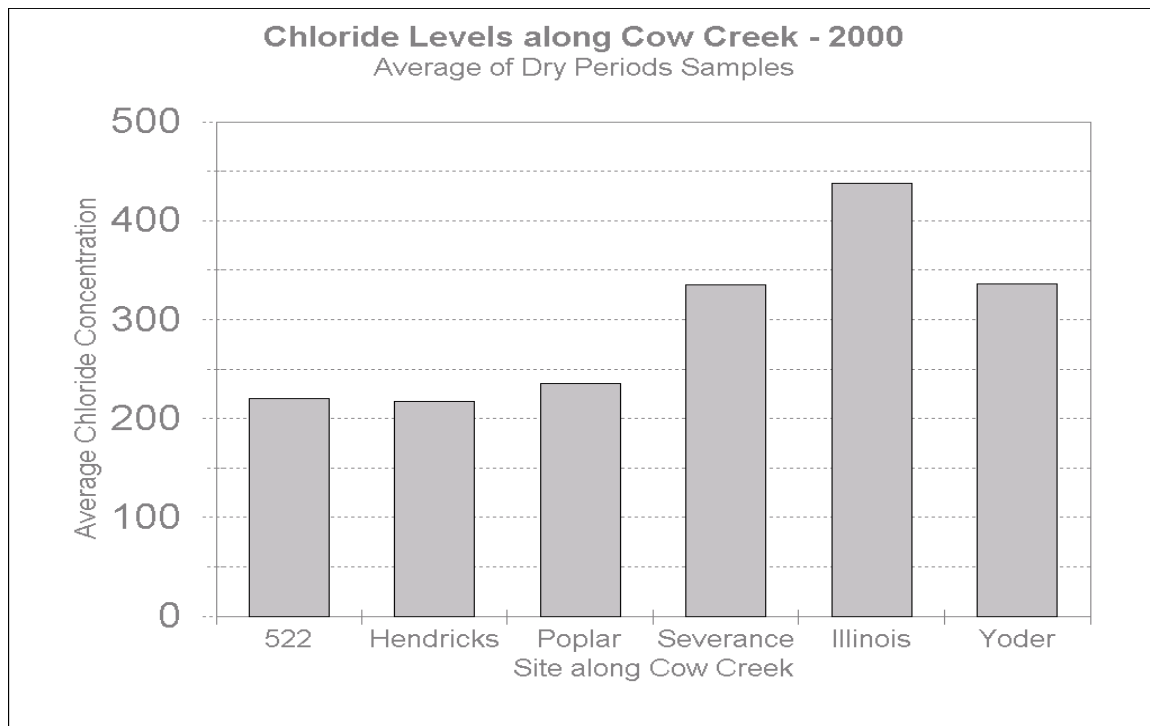


Figure 18. Chloride Levels Along Cow Creek Flowing Through Hutchinson

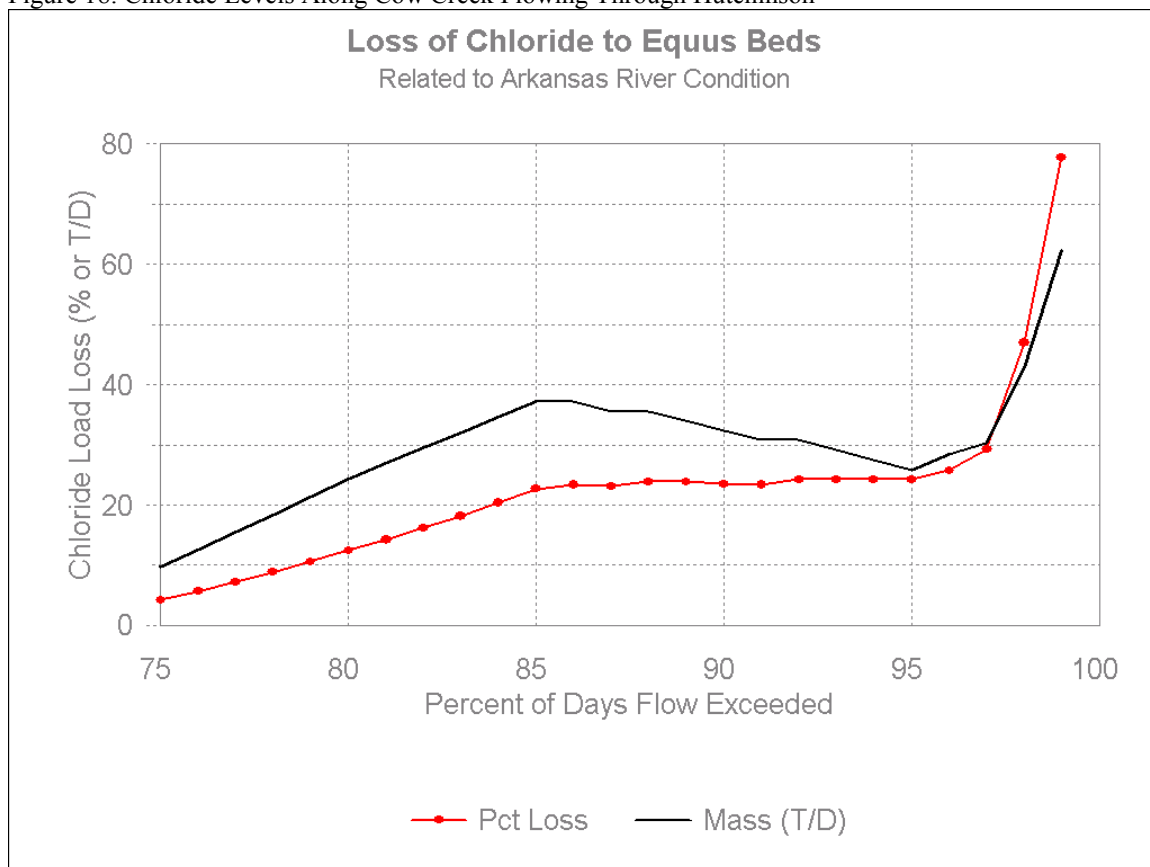


Figure 19. Estimated Loss of Chloride Mass between Hutchinson and Maize
(Hutchinson flows: 140 cfs @ 75%; 100 cfs @ 85%; 66 cfs @ 95%; 45 cfs @ 99%)

percentage loss is about 25% and the lost mass is slightly less than 40 tons per day. The second mass endpoint of this TMDL is intended to protect the quality of the water within the Equus Beds. Because both the Arkansas River and Cow Creek contribute this mass, they will be dealt with concurrently to achieve this endpoint. The mass endpoint to be attained under this TMDL will be to decrease the chloride load loss to under 50 tons per day at critical low flows and maintain the loss below 40 tons per day at higher flows.

3. SOURCE INVENTORY AND ASSESSMENT

Background Concentrations: Groundwater from the Permian geologic formations underlying the southern and western drainages to the Arkansas River have a naturally high level of chloride through the dissolution of rock salt contained within that geology. Natural intrusion of salt water has been noted for Rattlesnake Creek, Peace Creek and Salt Creek. Because of the typically low contributions of relatively freshwater from the river drainages west of Dodge City, most of the water comprising the flow seen at Nickerson comes from the southern tributaries and ground water inflow. At Station 523, assuming a critical low flow at Nickerson of 11 cfs, the estimated flow during October 1991, there is an estimated 17.3 tons per day of chloride, based on an average concentration of 580 mg/l. Accounting for contributions from upstream point sources such as Great Bend, Ellinwood and Nickerson, the tributary non-point contribution at that station is about 84%. The major upstream point source is Great Bend, discharging an average of 345 mg/l of chloride. This wastewater discharge actually dilutes the background concentration in the river. Without this dilution base from Great Bend (as well as contributions from Ellinwood and Nickerson), the background concentration computed at Station 523 would be around 650 mg/l. Accounting only for Ellinwood and Nickerson with their elevated chloride concentrations, the background concentration would be reduced only 1-3 mg/l because of the small volume of wastewater contributed by those two point sources.

Overall average chloride concentrations on the three southern tributaries are: 2840 mg/l on Rattlesnake Creek, 1900 mg/l on Peace Creek and 1380 mg/l on Salt Creek. There appears to be more dilution as one moves eastward along the Arkansas River. Existing TMDLs for Rattlesnake Creek and Peace Creek establish chloride endpoints reflecting elevated background levels of 3660 and 1800 mg/l, respectively. In order for chloride concentrations to be in the 500-700 mg/l range on the Arkansas River below Rattlesnake and Peace Creeks, there needs to be small flow contributions from those streams and a good dilution source entering the river. Dilution sources might include flow moving along the river from its western reaches, the wastewater discharge of Great Bend or freshwater ground water inflow from the north side of the river. Given the moderate amounts of chloride seen on Cow Creek near Willowbrook, it is likely that a northern freshwater aquifer is providing seepage to the Arkansas River and diluting the impact of the southside contributions.

Point Source Contributions: There are five principal dischargers in the Hutchinson region that contribute varying amounts of chloride to the river. Three, Morton Salt, South Hutchinson and Hutchinson discharge directly to the river. The other two, Cargill Salt and the Cessna-Eaton (Textron) ground water remediation project, discharge into Cow Creek east of Hutchinson. Table 6 shows the average discharge and chloride concentration for the five dischargers over 2000-2002 and, specifically, for 2002.

Table 6. Average Wastewater Flow and Chloride from Dischargers in the Hutchinson Vicinity

	2000-2002	2000-2002	2002	2002
Discharger	Wastewater Flow	Average Chloride Conc.	Wastewater Flow	Average Chloride Conc.
Hutchinson	5.68 MGD	390 mg/l	4.84 MGD	393 mg/l
South Hutchinson	0.70 MGD	725 mg/l	0.72 MGD	778 mg/l
Morton Salt	5.56 MGD	887 mg/l	5.51 MGD	934 mg/l
Cargill Salt	3.91 MGD	539 mg/l	4.32 MGD	517 mg/l
Cessna-Eaton	1.75 MGD	572 mg/l	1.59 MGD	569 mg/l

Figure 1 shows the location of the water quality and streamflow monitoring stations along the Arkansas River and Cow Creek and the major dischargers to the two streams. Figures 20 and 21 display the pattern of chloride content in the wastewater of the dischargers to the Arkansas River and Cow Creek, respectively. Figure 20 clearly shows Hutchinson wastewater provides a stable dilution base into the river, whereas South Hutchinson and Morton Salt have fluctuating chloride levels that tend to exceed the intended background concentrations for the river. There appears to be an increasing trend in chloride concentration at South Hutchinson over time and Morton looks to have increased chloride recently, as well. As shown in Figure 21, both dischargers to Cow Creek have chloride levels over the intended background concentration of 275-340 mg/l.

In comparing the volumes of the wastewater discharges, Figure 22 shows Hutchinson and Morton Salt to be comparable, around 5-6 MGD. South Hutchinson, however, discharges slightly less than one MGD consistently. On Cow Creek, Figure 23 indicates widely fluctuating discharges from Cargill Salt, while Cessna-Eaton has been decreasing its discharge over time.

Considering both factors in load calculations points to Morton Salt as the major chloride contributor to the stream system (Figure 24). Hutchinson, because of its flow rate, is comparable to Cargill Salt, with its elevated chloride discharges. Cessna-Eaton and South Hutchinson are the smaller contributors of chloride mass, despite the elevated chloride concentrations of their wastewater.

Mass Balance Analysis: In order to assess the impact of the various dischargers and possible controls on the concentrations and mass of chloride discharged to the Arkansas River and Cow Creek, a mass balance spreadsheet was developed. The position schematic of the key components to the balance analysis is provided in the Appendix as A-1. The spreadsheet was calibrated by examining flow and concentrations during the October 1991 period, when the river suffered substantial loss of flow between Hutchinson and Maize. The calibration process established the amount of gain and loss along the river between the USGS Nickerson gage and the Maize gage and the relative contributions to the river.

Flows from Cow and Salt Creeks and the upstream entry point (Nickerson) were estimated using the ambient concentrations and flows along the Arkansas River as guides. Discharge records for

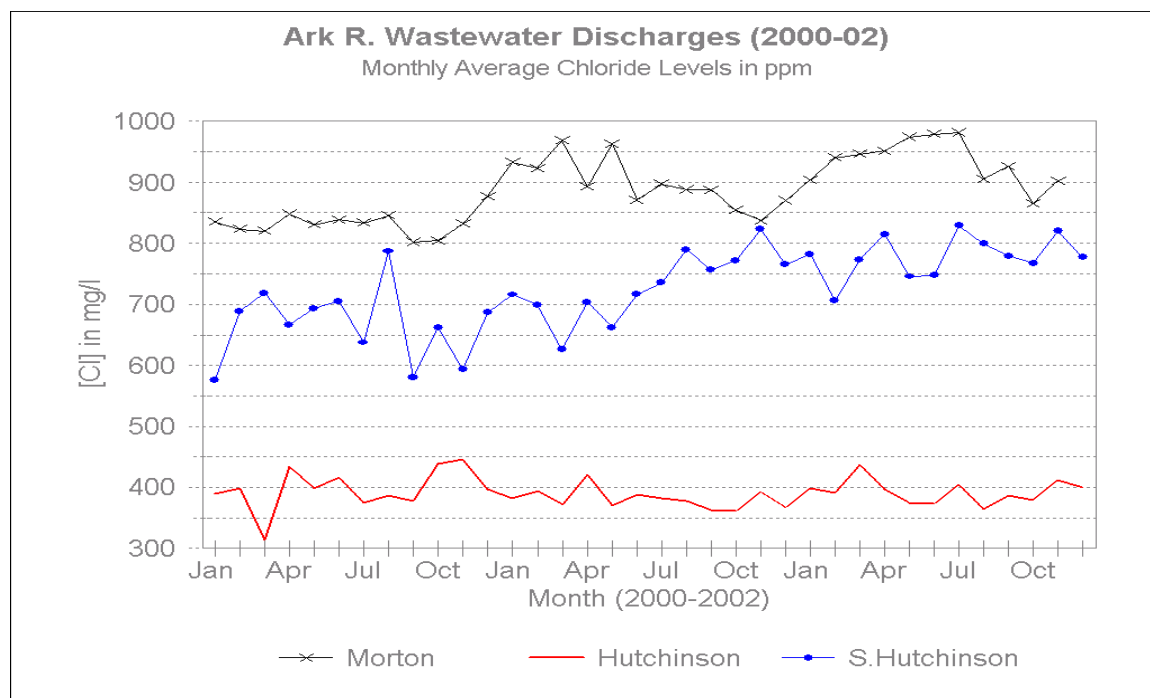


Figure 20. Chloride Content of Arkansas River Dischargers

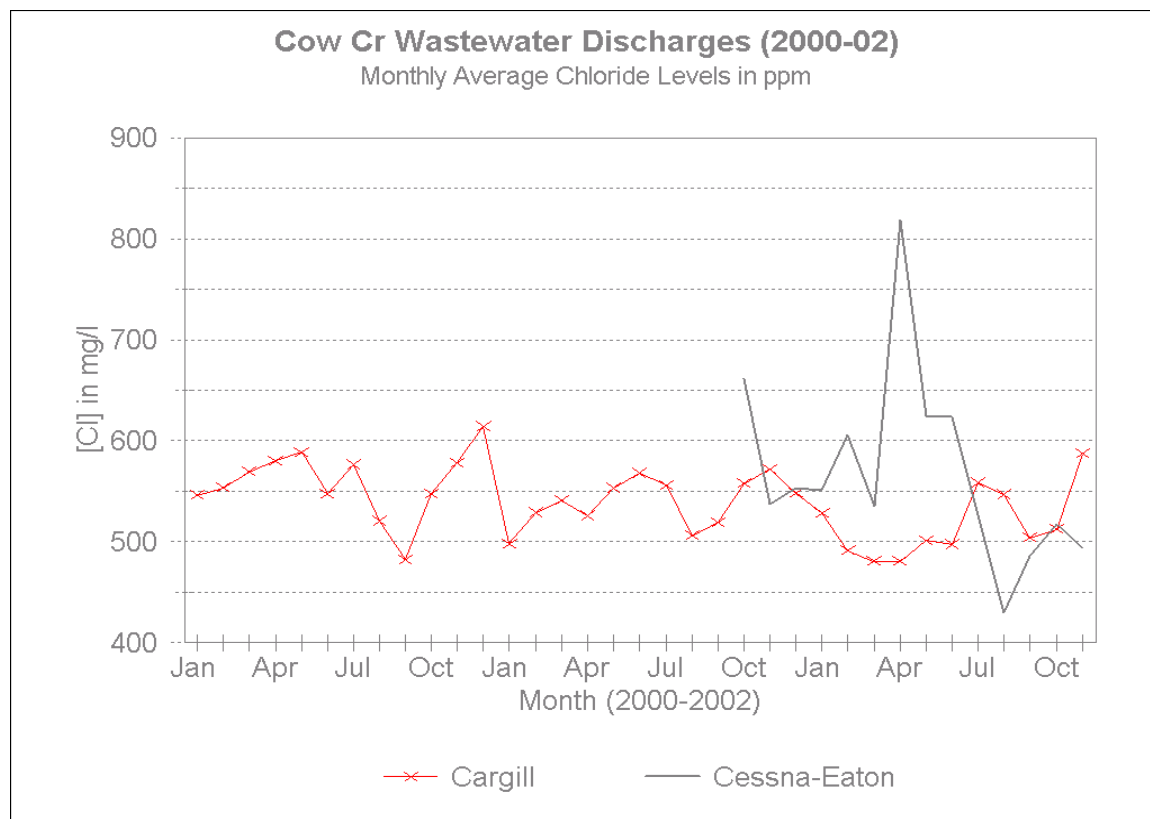


Figure 21. Chloride Content of Cow Creek Dischargers

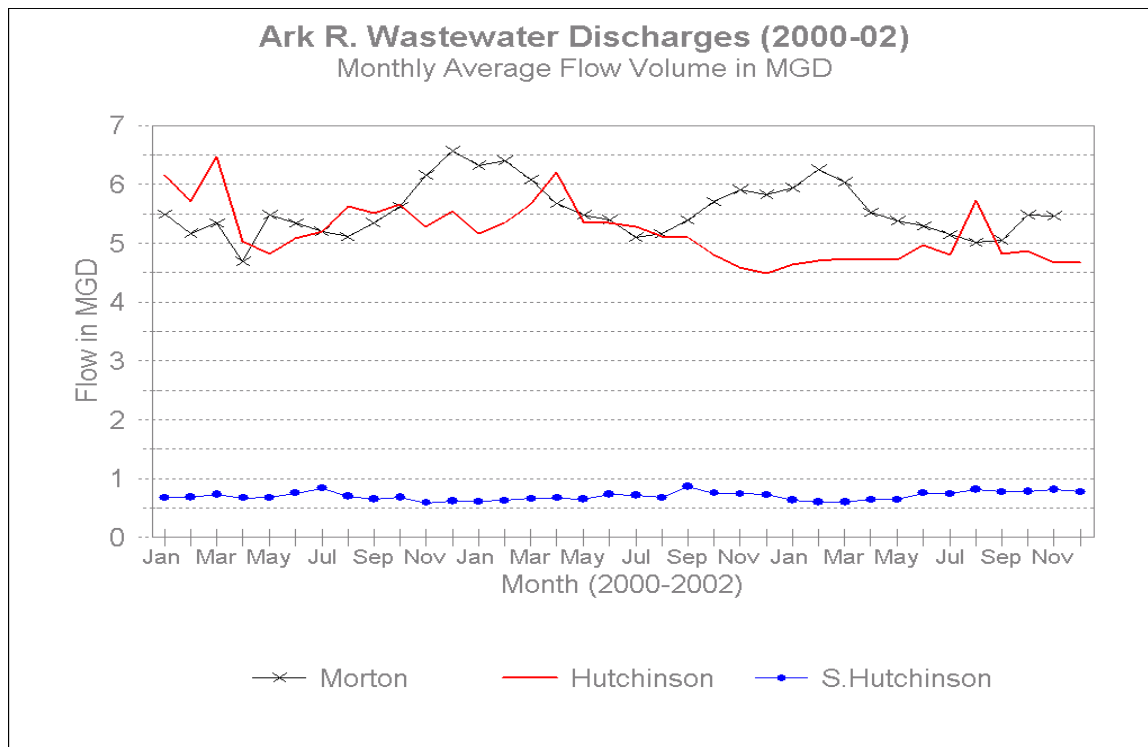


Figure 22. Wastewater Volume of Arkansas River Dischargers

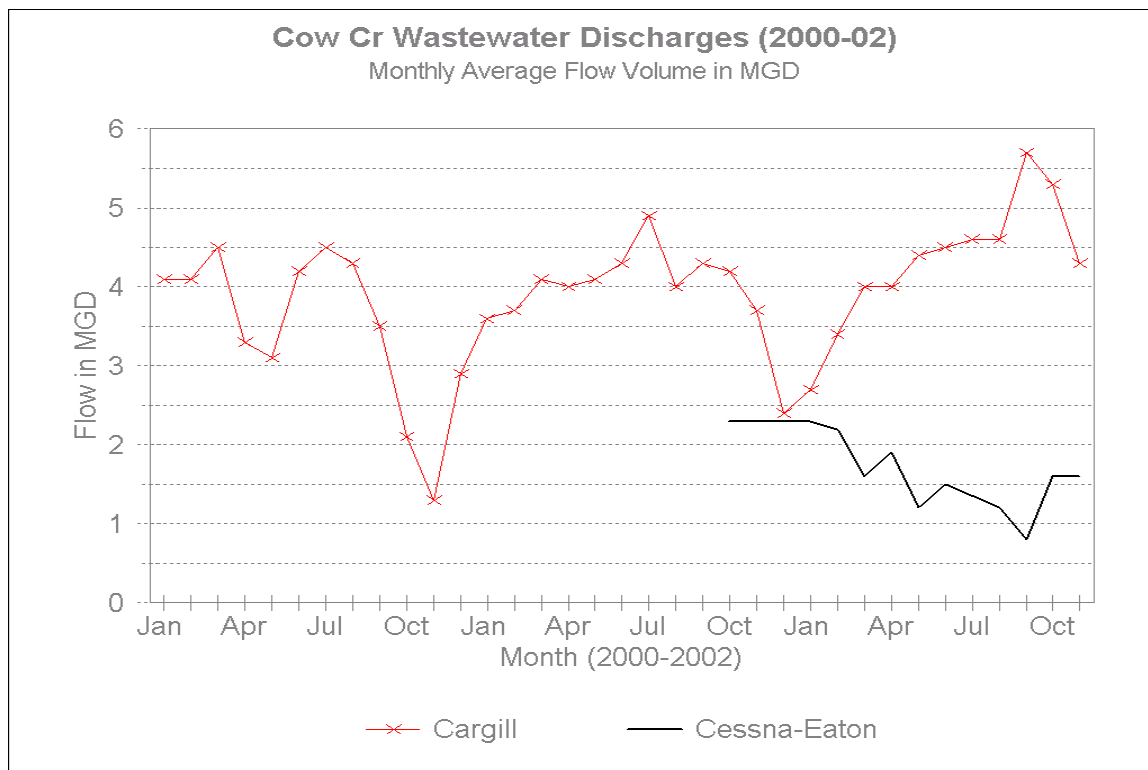


Figure 23. Wastewater Volume of Cow Creek Dischargers

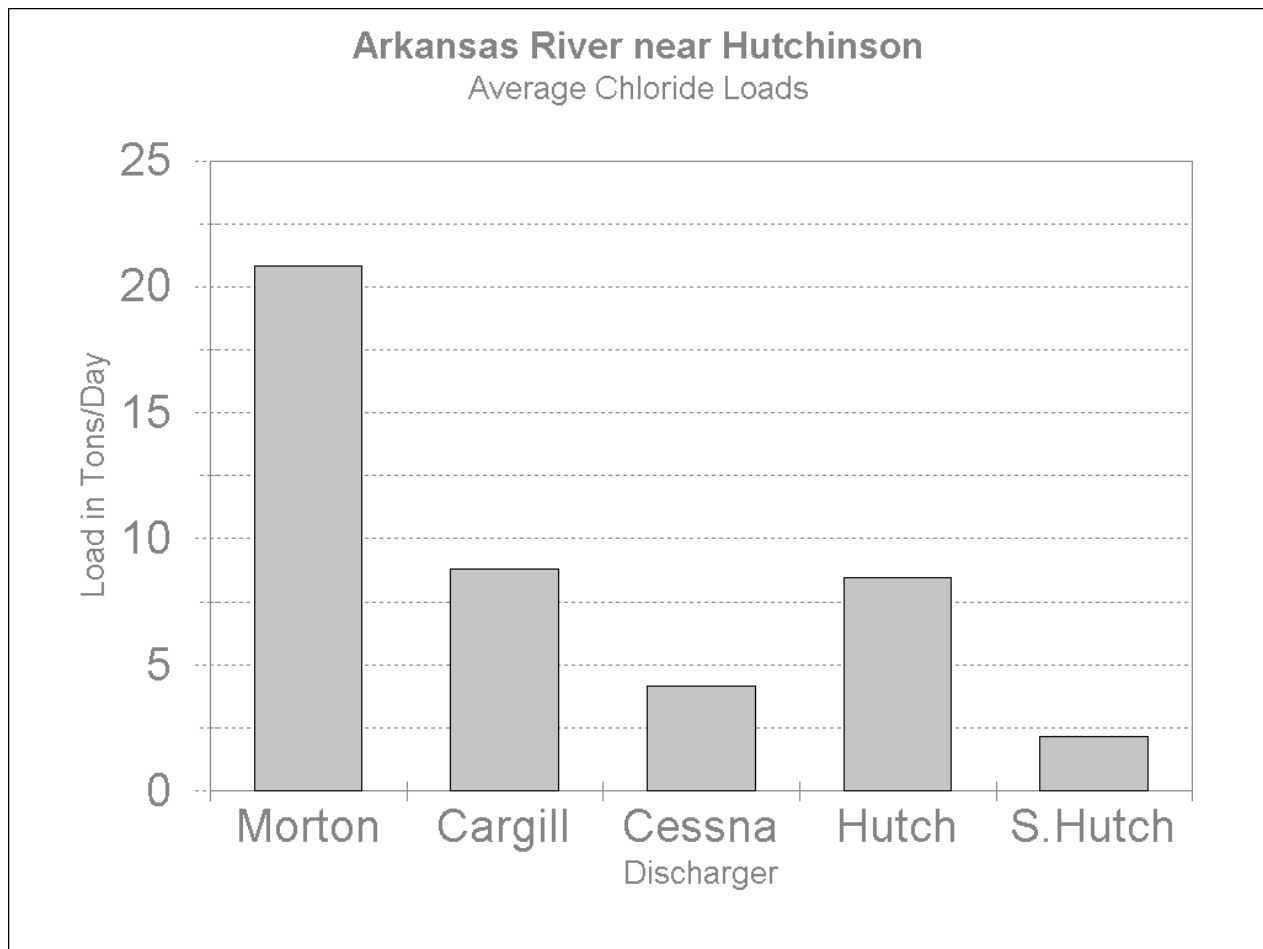


Figure 24. Relative Loads of Main Dischargers in Hutchinson.

the point sources were obtained from KDHE files. Cow Creek was assumed, at low flow, to have a portion (10%) of its flow continue to the Arkansas River along the diversion ditch west of Hutchinson. Ten percent of the remaining flow was assumed to reach the river via the Harsha Canal. The remaining flow continued down the original channel of Cow Creek until it met the Arkansas River east of Hutchinson.

Two flow conditions were assessed for impact analysis; 1) the critical low flow of 45 cfs at the Hutchinson gage, which is comparable to the 7Q10 low flow; and, 2) the upper quartile flow of 100 cfs, beyond which chloride concentrations at Stations 523 and 524 are indistinguishable. The October 1991 calibration analysis is provided in the Appendix as A-2.

In 1991, there was no discharge by Cessna-Eaton, but there was wastewater provided to Cow Creek by North American Salt (aka Carey Salt and IMC Salt). That discharge ceased in 1998. Wastewater from Cessna-Eaton began to be discharged in 1993, but chloride was not monitored until Autumn 2001. A contemporary baseline simulation was established, using the 2000-2002 average wastewater discharges to reflect the current condition. This simulation is provided in the Appendix as A-3.

Alterations in the discharge rate and concentration for the point sources were assessed using the spreadsheet and the impacts on chloride concentrations seen at Stations 287 and 524 and the mass lost to the aquifer in the vicinity of Station 536 were noted. 2002 baseline conditions indicated that the concentration of chloride at Station 524 was 617 mg/l, the chloride concentration on Cow Creek was 482 mg/l at Station 287 and the estimated loss of chloride in the vicinity of Maize was 55.4 tons per day.

Limitations on Chloride Dischargers: Table 7 displays the individual impact of each of the four high chloride dischargers on the downstream concentrations and mass lost to the Arkansas River alluvium. The impact was analyzed by comparing the base condition with a new condition where the discharger had limits placed on their effluent. For the Arkansas River dischargers, the limit was the midpoint of the background concentration range or 575 mg/l. For Cow Creek, the discharge was limited to 300 mg/l for Cargill and Cessna-Eaton.

It is apparent that Morton is the dominant influence on the Arkansas River and South Hutchinson is a minor contributor, despite its elevated chloride concentrations in wastewater. Cargill is more influential than Cessna-Eaton on chloride content along Cow Creek, but both discharges need to be limited in order to meet the Cow Creek endpoint. Limiting Morton would achieve both of the Arkansas River TMDL endpoints, although the mass loss goal is barely met. Limitation of South Hutchinson at the same time improves those results slightly, while concurrent controls on the Cow Creek dischargers, especially Cargill, substantially achieve all of the desired endpoints. Hutchinson was not evaluated because its discharge currently is below background concentrations.

Impact of Design Flows: There is substantial room to increase the discharges from South Hutchinson, Hutchinson and Cessna-Eaton. South Hutchinson can increase its wastewater volume from the current level of 0.7 MGD to 2.0 MGD. This would increase the load from South Hutchinson by 3.9 tons per day from current loading levels. Hutchinson may increase its discharge from the current average of 5.68 MGD to 8.3 MGD. Although the concentration of its wastewater may remain below 400 mg/l, the mass loading from the city increases from 9.3 tons per day to 13.5 tons per day. This would work against achieving lost mass endpoint of the TMDL. Table 8 shows the impact of increasing wastewater to design flows with and without limits in place. Once again, South Hutchinson has relatively little impact, although it does substantially raise the amount of mass potentially lost downstream. At design flows, the concentration endpoint at Station 524 can be met through a combination of effluent limits, however, the mass endpoint will not be achieved.

Table 7. Impact of Individual Dischargers on Station 524 Concentrations and Maize Mass Loss

Scenario	Station 524 [Target: 550-595 mg/l]	Station 287 [Target: 275-340 mg/l]	Mass Loss at Maize [Target: <50 tons per day]
Base	617 mg/l	482 mg/l	55.4 t/d
S. Hutchinson limited	612 mg/l	-----	55.1 t/d
Morton limited	528 mg/l	-----	49.7 t/d
Cargill limited	-----	356 mg/l	52.4 t/d
Cessna-Eaton limited	-----	419 mg/l	53.9 t/d
Morton & S. Hutch	523 mg/l	-----	49.4 t/d
Cessna & Cargill	-----	292 mg/l	50.9 t/d
Industrial Dischargers	528 mg/l	292 mg/l	45.1 t/d
Salt Companies	528 mg/l	356 mg/l	46.7 t/d
All Four Dischargers	523 mg/l	292 mg/l	44.8 t/d

Table 8. Impact of Hutchinson and South Hutchinson Design Flows on TMDL Endpoints.

Scenario	Station 524 Chloride [Target: 550-595 mg/l]	Mass Lost at Maize [Target: < 50 tons per day]
S. Hutch @ DF; No Limits	624 mg/l	58.5 tons per day
S. Hutch @ DF; Limited	610 mg/l	57.5 tons per day
S. Hutch @ DF; Morton limited	541 mg/l	52.8 tons per day
S. Hutch @ DF; Both limited	526 mg/l	51.8 tons per day
Hutch @ DF; No limits	591 mg/l	58.8 tons per day
Hutch & S. Hutch @ DF; No Limits	598 mg/l	61.8 tons per day
Both @ DF; Morton Limited	524 mg/l	56.1 tons per day
Both @ DF; Both Limited	511 mg/l	55.2 tons per day
Both @ DF; All Four Limited	511 mg/l	50.6 tons per day

Impact of the Cessna-Eaton Design Flow

The Cessna Eaton remediation project can discharge at a design flow of 2000 gpm (2.88 MGD; 4.46 cfs). Table 9 indicates the impact of this increased discharges and loading on Cow Creek and loss of mass at Maize. With limits, the Cow Creek chloride endpoint can be met and under current discharge levels with limits, the mass endpoint could be met, as well. But under a scenario where Hutchinson and South Hutchinson reach design flows, the amount of mass lost

exceeds 51 tons per day. In order to achieve the mass endpoint at design flow levels, proportional reductions would be necessary for all five discharges. The limits on chloride would need to be: Morton, 540 mg/l; South Hutchinson, 550 mg/l; Hutchinson, 370 mg/l; Cargill and Cessna-Eaton, 280 mg/l. These limits would reduce the mass lost at Maize to less than 50 tons per day.

Table 9. Impact of Cessna-Eaton Discharging at Design Flows

Scenario	Station 287 Cl Concentration (target: 275-340 mg/l)	Mass Lost at Maize (target: < 50 tons per day)
No limits & current flows	494 mg/l	57.6 t/d
300 mg/l limit on Cessna	403 mg/l	55.0 t/d
Cessna & Cargill limited	293 mg/l	52.0 t/d
Ark-Current flows with limits	293 mg/l	45.9 t/d
All at design flows with S. Hutch & Morton limited	293 mg/l	51.7 t/d

Elimination of Certain Loads: Imposing limits on the concentration of chloride in certain discharges will work toward achieving the endpoints of this TMDL, but can be offset by increased loads generated by future growth. There are alternatives for disposing of chloride-laden wastewater, such as retention of effluent in storage lagoons or deep well injection. If the wastewater of all but Hutchinson was no longer discharged into the streams, downstream concentrations under critical low flows will decrease and, more importantly, the chloride mass delivered to the Maize area will be reduced substantially.

Table 10 shows the impact of eliminating individual or combinations of the wasteloads from the main chloride contributors in Hutchinson. Elimination of the Morton discharge single-handedly allows the achievement of both endpoints of this TMDL along the Arkansas River. Elimination of both Cessna-Eaton and Cargill is necessary to achieve the Cow Creek endpoint. Even with increased wastewater flows at Hutchinson and South Hutchinson, the endpoints are met if the industrial discharges are disposed by means other than discharge to the waterways.

Table 10. Impact of Eliminating Chloride Discharges on Chloride Concentration and Mass Loss

Scenario	Station 524 Chloride [Target: 550-595 mg/l]	Station 287 Chloride [Target: 275-340 mg/l]	Mass Lost @ Maize [Target: < 50 tons per day]
Eliminate Morton	510 mg/l	-----	39.3 tons per day
Eliminate Cargill	-----	418 mg/l	48.6 tons per day
Eliminate Cessna-Eat	-----	455 mg/l	52.2 tons per day
Morton & Cargill	510 mg/l	418 mg/l	32.4 tons per day
Cargill & Cessna	-----	267 mg/l	45.3 tons per day
Eliminate all 3	510 mg/l	267 mg/l	29.2 tons per day
Design Q, industry off	508 mg/l	267 mg/l	35.6 tons per day
Eliminate S.Hutch, too	481 mg/l	267 mg/l	30.9 tons per day

Addition of a New Source: The elimination of certain dischargers creates a possible allocation of chloride load for new dischargers while maintaining to the endpoints of the TMDL. Numerous ground water remediation projects potentially could discharge to the streams, provide the existing discharges were curtailed. Additionally, the Cessna-Eaton remediation project could discharge to

the Arkansas River rather than Cow Creek. Table 11 displays the impact of alternative discharges if certain existing discharges are eliminated. The scenarios presume South Hutchinson, Hutchinson and Cessna-Eaton discharge at design flows and existing average chloride levels. Cessna-Eaton is evaluated for discharging to the Arkansas River at its average of 570 mg/l as well as being eliminated by deep well disposal. Scenarios are evaluated with Morton discharge eliminated, limited (575 mg/l) or discharging a domestic-type wastewater (2 MGD @ 400 mg/l Cl). Any new discharge is assumed to discharge at the acute aquatic life limit of 860 mg/l and is limited in volume by the TMDL endpoints. No new high chloride discharges should be allowed into Cow Creek. Cow Creek also benefits from the Cessna-Eaton discharge moving to the Arkansas River.

Table 11. Impact of New Discharges when Morton and Cargill Discharges are Eliminated.

Scenario	Station 524 Cl Target: 550-595 mg/l	Station 287 Cl Target: 275-340 mg/l	Mass Lost at Maize Target: < 50 tons/day
Cessna-Eaton to Ark	517 mg/l	267 mg/l	40.9 tons per day
New Discharge (0.25 MGD) to Cow	517 mg/l	340 mg/l	41.6 tons per day
New Discharge (3.2 MGD) to Ark	562 mg/l	267 mg/l	49.9 tons per day
New Discharge (5.1 MGD) to Ark; no Cessna	586 mg/l	267 mg/l	49.9 tons per day
New Discharge (2.1 MGD) to Ark; Morton limited	542 mg/l	267 mg/l	49.8 tons per day
Cessna to Ark; Morton domestic	506 mg/l	267 mg/l	43.5 tons per day
Same as previous plus New Discharge (2.25 MGD)	538 mg/l	267 mg/l	49.9 tons per day

Impacts at Higher Flows: Mass balance relations were examined when flows below Hutchinson reached 100 cfs. At that flow condition, the distinction between chloride concentrations at Stations 523 and 524 begins to lose significance. Additionally, the loss of water between Hutchinson and Maize is decreased to about 25 percent. Table 12 shows the corresponding stream conditions for certain scenarios at this higher flow. Flow on Cow Creek at Willowbrook is assumed to be 5.5 cfs under these improved baseflow conditions. Chloride levels entering the reach from above Hutchinson will be higher than those seen at the previous low flow condition because of the increased flows from southern tributaries. As shown in the table, the upper limit of the Arkansas River concentration endpoint is generally met through effluent limits or alternative disposal, even with increased flows from the municipalities. The addition of a new discharger on the Arkansas River would push the concentration over 600 mg/l, but would be reduced if Morton discharged their potable water and injected their process water. Cow Creek endpoints need limits or discharge elimination to be achieved. Because the amount of water and mass lost to the aquifer is reduced proportionately at these higher flows, the targeted goal would be 40 tons per day or less chloride lost to the aquifer. One would expect the impact of the point source contributions to decrease further with higher diluting flows entering from upstream.

Table 12. Impact of Chloride Loading at 100 CFS on Stream Concentrations and Mass Loss

Scenario	Station 524 Chloride [Target: 550-595 mg/l]	Station 287 Chloride [Target: 275-340 mg/l]	Mass Lost @ Maize [Target: < 40 tons per day]
Base Condition	638 mg/l	431 mg/l	41.7 tons per day
Design Flows Impact	628 mg/l	445 mg/l	44.5 tons per day
Effluent Limits Impact	588 mg/l	297 mg/l	40.3 tons per day
Eliminate Salt Discharges	599 mg/l	295 mg/l	36.3 tons per day
Move Cessna to Ark	598 mg/l	293 mg/l	37.1 tons per day
Additional Discharge Impact	607 mg/l	293 mg/l	38.9 tons per day
Impact of Morton Domestic Discharge	600 mg/l	292 mg/l	39.7 tons per day

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

Point Sources: As seen from the previous analysis, the various allocations among the dischargers have disproportionate impacts on the achievement of the TMDL endpoints on the Arkansas River and Cow Creek. There are two primary scenarios for load reduction by the dischargers involving concentration reduction or load elimination. These scenarios depend upon the treatment option selected by Morton Salt, the major load contributor. Table 13 displays the various allocations assigned to present and future dischargers and sources under the two scenarios.

The first option requires reducing the chloride concentration of the Morton discharge to 570 mg/l. Hutchinson, South Hutchinson, Cargill and Cessna-Eaton would also need to reduce chloride concentrations in order to achieve the Cow Creek endpoint and the mass endpoint at Maize. No additional loadings would be allowed on either stream under this scenario.

As a second option, if Morton chose to dispose of its high chloride wastewater by deep injection rather than continue to discharge to the Arkansas River, its wasteload allocation approaches zero. Similarly, Cargill could also dispose by deep injection as well, improving the condition of Cow Creek. This scenario allows Hutchinson to continue to discharge at current concentrations up to design flow levels. The elimination of the salt plant discharges creates the opportunity to use the assimilative capacity of the Arkansas River to shift the Cessna-Eaton discharge from Cow Creek to Arkansas River. Several points to this scenario:

1. Once again, Cow Creek is improved by the effective elimination of the chloride discharge. Cessna-Eaton would not have to treat its effluent because its average chloride concentration is equivalent to the background concentrations of the Arkansas River.
2. There would be capacity to accommodate a new discharger to the Arkansas River. There are potentially a number of ground water remediation projects in the Hutchinson area that will strip VOC's from the ground water but discharges the remaining high

chloride water to area surface waters. Typically, this water would be disposed by deep injection or routed to a regional reverse osmosis system. Any limited amount of water discharged into the Arkansas River could not exceed 860 mg/l in chloride because of the acute criterion for aquatic life. Moreover, there are equity considerations in removing existing dischargers from the streams while allowing new dischargers. Any excess assimilative capacity of the Arkansas River will be held in reserve by KDHE to incorporate in the Margin of Safety of this TMDL or to accommodate future growth and consequent loads or accommodate discharge of domestic level wastewater from Morton. Table 13 examines the impact of these options.

Table 13. Load Allocations and Endpoints for Chloride in the Arkansas River and Cow Creek

----- Treatment Option for Morton Salt-----

Source, Allocation and Endpoint	Reduce Cl Concentration	Eliminate Salt Discharge	Discharge 2 MGD at Domestic Quality
Morton Salt Wasteload	13.2 tons per day	0.0 tons per day	3.3 tons per day
Hutchinson Wasteload	12.8 tons per day	13.5 tons per day	13.5 tons per day
S. Hutchinson Wasteload	4.8 tons per day	4.8 tons per day	4.8 tons per day
Cargill Salt Wasteload	4.9 tons per day	0.0 tons per day	0.0 tons per day
Cessna-Eaton Wasteload to Cow Creek	2.2 tons per day	0.0 tons per day	0.0 tons per day
Cessna-Eaton Wasteload to Arkansas River	0.0 tons per day	6.9 tons per day	6.9 tons per day
New Discharger Wasteload to Cow Creek	0.0 tons per day	0.0 tons per day	0.0 tons per day
KDHE Reserve Wasteload to Ark River	0.0 tons per day	10.8 tons per day	7.2 tons per day
Total Wasteload Allocation	37.9 tons per day	36.0 tons per day	35.7 tons per day
Load Allocation in Ark	24.1 tons per day	24.1 tons per day	24.1 tons per day
Load Allocation in Cow	2.0 tons per day	2.0 tons per day	2.0 tons per day
Total Load Allocation	26.1 tons per day	26.1 tons per day	26.1 tons per day
Margin of Safety on Ark	0.9 tons per day	1.1 tons per day	1.2 tons per day
Margin of Safety on Cow	1.4 tons per day	0.9 tons per day	0.9 tons per day
Total Margin of Safety	2.3 tons per day	2.0 tons per day	2.1 tons per day
TMDL for Arkansas R.	55.8 tons per day	61.2 tons per day	61.0 tons per day
TMDL for Cow Creek	10.5 tons per day	2.9 tons per day	2.9 tons per day
Total TMDL	66.3 tons per day	64.1 tons per day	63.9 tons per day
Station 524 [Chloride]	503 mg/l	547 mg/l	523 mg/l
Station 287 [Chloride]	292 mg/l	267 mg/l	267 mg/l
Mass Lost at Maize	49.9 tons per day	48.4 tons per day	48.2 tons per day

3. The removal of discharges to Cow Creek does not create similar opportunities for new loadings because of the limited assimilative capacity of the stream and the concentration endpoint at Station 287. Therefore, no new high chloride discharges should be permitted into Cow Creek.
4. This scenario is at the discretion of the dischargers; KDHE has authority to impose the first scenario but cannot force the second scenario into reality without the consent and agreement of the dischargers. Therefore, the default allocations of this TMDL will be those defined under the first scenario. The second scenario or some variation of it involving pollutant trades or partial treatment will be acceptable but will need to be initiated by the dischargers if their analysis shows those alternatives to be more cost-effective than the first scenario.

Under these options for wasteload allocation, the three endpoints for the Arkansas River and Cow Creek would be achieved. Actual permit limits could be adjusted to reflect revisions in design flows or disposal methods, provided the wasteload allocations were not exceeded by each of the dischargers. Trading of allocations would also be permissible, again provided the total wasteload allocation was not exceeded. In the case of the discharges to the Arkansas River, permit limits should ensure that the maximum chloride concentration discharged over a week was 860 mg/l or lower, to maintain compliance of the chloride acute criterion in the river. In no cases, should weekly maximums exceed levels seen over 2000-2002. Because of the seven to 30 day duration for the critical low flow periods of concern by this TMDL, permit limits should be expressed as monthly averages.

Non-Point Sources: There is substantial loading contributed from natural sources. These sources include the Arkansas River itself above Hutchinson (16.3 tons per day); Cow Creek contributions from the diversion ditch and Harsha Canal (each 0.1 tons per day); Salt Creek (2.2 tons per day); Cow Creek above the Cargill outfall (0.7 tons per day) and seepage from regional ground water. The ground water north of the river tends to be fairly fresh and is assumed to yield 1.3 tons per day, while the southern seepage is elevated in chloride, albeit less than levels seen in the tributaries to the west (5.4 tons per day).

Therefore, the load allocation above Station 524 is 18.7 tons per day at the critical low flow condition, when point source impacts can be discerned. The load allocation contributed to the river by southern seepage between Station 524 and Station 536 at Maize is 5.4 tons per day. The load allocation contributed by Cow Creek along the original channel above Station 287 is 2.0 tons per day. In total, the load allocation is 26.1 tons per day for the Arkansas River system above Station 536 at Maize.

As flows increase toward 100 cfs, the load allocation increases to 106.6 tons per day above Station 524, 9.5 tons per day between Stations 524 and 536 and 5.9 tons per day from Cow Creek, totaling 122 tons per day.

Defined Margin of Safety: The Margin of Safety is established explicitly at a number of points in developing this TMDL. First, the midpoint of the background concentration range on both streams was used to establish the wasteload allocation for the dischargers, as opposed to using the upper bound of the range. This ensures the point source contributions do not cause the average concentrations at the endpoint stations to rise above the background range.

Second, each present or future discharger was capped in terms of the mass load allowed to be discharged, in order that the Maize mass endpoint was assured. In some cases, this required a lower concentration than the assigned background level at design flows.

Third, new discharges could not take full advantage of the assimilative capacity created by eliminating certain current discharges. In the case of Cow Creek, no new discharges are allowed, although with the removal of Cessna-Eaton and Cargill, a loading of 0.9 tons per day would achieve the Cow Creek concentration endpoint. In the case of the Arkansas River, the only new discharge allowed in the foreseeable future would be Cessna-Eaton because of the benefit to Cow Creek. Any new allowable discharge could not take advantage of the assimilative capacity created by the reduction or elimination of the Morton discharge without due consideration of the circumstances by KDHE.

Fourth, The maximum concentration to be discharged to the Arkansas River on any given day is set at 860 mg/l, consistent with the aquatic life acute criterion, and is to be met at the end of the pipe, to insure no excursions beyond the zone of initial dilution in the Arkansas River.

Finally, the wasteload allocations are not allowed to increase with increased flows in the streams, despite possible increases in the background concentrations at those flows. This ensures the endpoints are achieved, particularly, the Maize mass endpoint which is to maintain loss of chloride to the surrounding aquifer at rates below 40 tons per day under those flow conditions.

Table 14 shows the relative improvement in reduced loads and concentrations resulting from the wasteload allocations developed from the three options contemplated by this TMDL. Generally, a 9-46% improvement in water quality over design flow conditions is seen with the implementation of this TMDL.

Table 14. Load and Concentration Reductions Resulting from TMDL Wasteload Allocations

Endpoint/Option	Current Condition	Design Flow Condition	Morton Reducing Chlorides	Eliminating Salt Discharges	Morton Domestic Discharges
Load below 524	71.1 tons per day	82 t/d	64 t/d (-22%)	64.1 t/d (-22%)	61.8 t/d (-25%)
Stat 524 [Cl]	617 mg/l	598 mg/l	503 mg/l (-11%)	547 mg/l (-9%)	523 mg/l (-13%)
Stat 287 [Cl]	482 mg/l	494 mg/l	292 mg/l (-41%)	267 mg/l (-46%)	267 mg/l (-46%)
Maize Mass Lost	55.4 tons per day	63.9 t/d	49.9 t/d (-22%)	48.4 t/d (-24%)	48.2 t/d (-25%)

State Water Plan Implementation Priority: Because this river's chloride load is predominately natural, this TMDL will be a Low Priority for Water Plan implementation. However, as the TMDL relates to imposition of chloride control by point sources in the Hutchinson area during critical low flows on the Arkansas River, these activities should be viewed as High Priority.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Gar-Peace Subbasin (HUC 8: 11030010) with a priority ranking of 19 (High Priority for restoration work) and the lower portion of the Cow Subbasin (HUC 8: 11030011) with a priority ranking of 27 (Medium Priority for restoration work).

Priority HUC 11s and Stream Segments: Based on the location of the point sources, Segment 1 on the Arkansas River and Segment 1755 on Cow Creek will be the priority stream segments of concern for this TMDL.

5. IMPLEMENTATION

Desired Implementation Activities

1. Establish appropriate background concentrations
2. Reduce chloride discharges to streams by municipalities and industries
3. Reconfigure chloride discharges to streams from ground water remediation projects.

Implementation Programs Guidance

Water Quality Standards and Assessment - KDHE

- a. Link revised water quality standards to this TMDL as the basis for the background concentrations of 550-595 mg/l on the Arkansas River and 275-340 mg/l for the lowest segment of Cow Creek.

Industrial Programs - KDHE

- a. Develop a treatment plan and schedule of compliance for Morton Salt and Cargill Salt to reduce chloride discharges to background levels by 2010.
- b. Evaluate feasibility of deep well injection as alternative disposal method.
- c. Cap future chloride loads for Cessna-Eaton remediation project at design flow.

Municipal Programs – KDHE

- a. Cap future chloride loads for Hutchinson and South Hutchinson discharges at design flows.

Ground Water Remediation Program - KDHE

- a. Develop a treatment plan for the Cessna-Eaton project that will decrease the chloride discharges into Cow Creek.
- b. Evaluate alternative disposal methods for remediation wastewater.
- c. Evaluate opportunities to discharge moderate (~550 mg/l) levels of chloride to Arkansas River.

Timeframe for Implementation: Continued monitoring over the years 2003-2009. Development of a background level- based water quality standard should be accomplished with the 2003 triennial review of Kansas water quality standards. Implementation of reduced chloride treatment of discharges to the Arkansas River and Cow Creek should be in place by 2010

Targeted Participants: Primary participants for implementation will be municipal and industrial wastewater dischargers and ground water remediation projects within the affected area.

Milestone for 2008: The year 2008 marks the five-year milestone for implementing this TMDL for the stream reaches. At that point in time, additional monitoring data from Stations 523 and 522 will be re-examined to confirm the suggested background concentration. Plans for chloride reduction should be in place, ready for implementation by 2010.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Health and Environment, through its Municipal and Industrial Programs and its Bureau of Environmental Remediation.

Reasonable Assurances

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.
2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
3. The *Kansas Water Plan* and the Lower Arkansas River Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund, annually generates \$16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. Beyond implementation activities associated with the future permitting of wastewater discharges, this TMDL is a Low Priority consideration and should not receive State Water Plan funding.

Effectiveness: Chloride control may be accomplished through demineralization treatment of wastewater. However, deep well disposal may be more effective and cost efficient as a means of eliminating the chloride loading to streams by point sources.

6. MONITORING

KDHE will continue to collect bimonthly samples at Stations 522, 523, 524, 536 and 287, particularly chloride samples taken at low flow conditions (<100 cfs) monitored at the Hutchinson gage. Based on the appropriate sample data, suggested background concentrations may be revised over 2006-2009. Monitoring for evaluating implementation will commence by 2010 to document achievement of the endpoints of this TMDL and subsequent delisting of these streams from the Section 303d list in 2012.

7. FEEDBACK

Public Meetings: A draft of this TMDL is on the website as of August 27, 2003 and modifications to the original draft will be available to the public for viewing and review up to the date of submitting this TMDL to EPA. A Public Meeting to discuss this TMDL will be held TBD.

Public Hearing: A Public Hearing on the original draft of this TMDL will be held TBD

Basin Advisory Committee: The Lower Arkansas River Basin Advisory Committee met to discuss the TMDLs in the basin on June 4, 2003 and September 16, 2003.

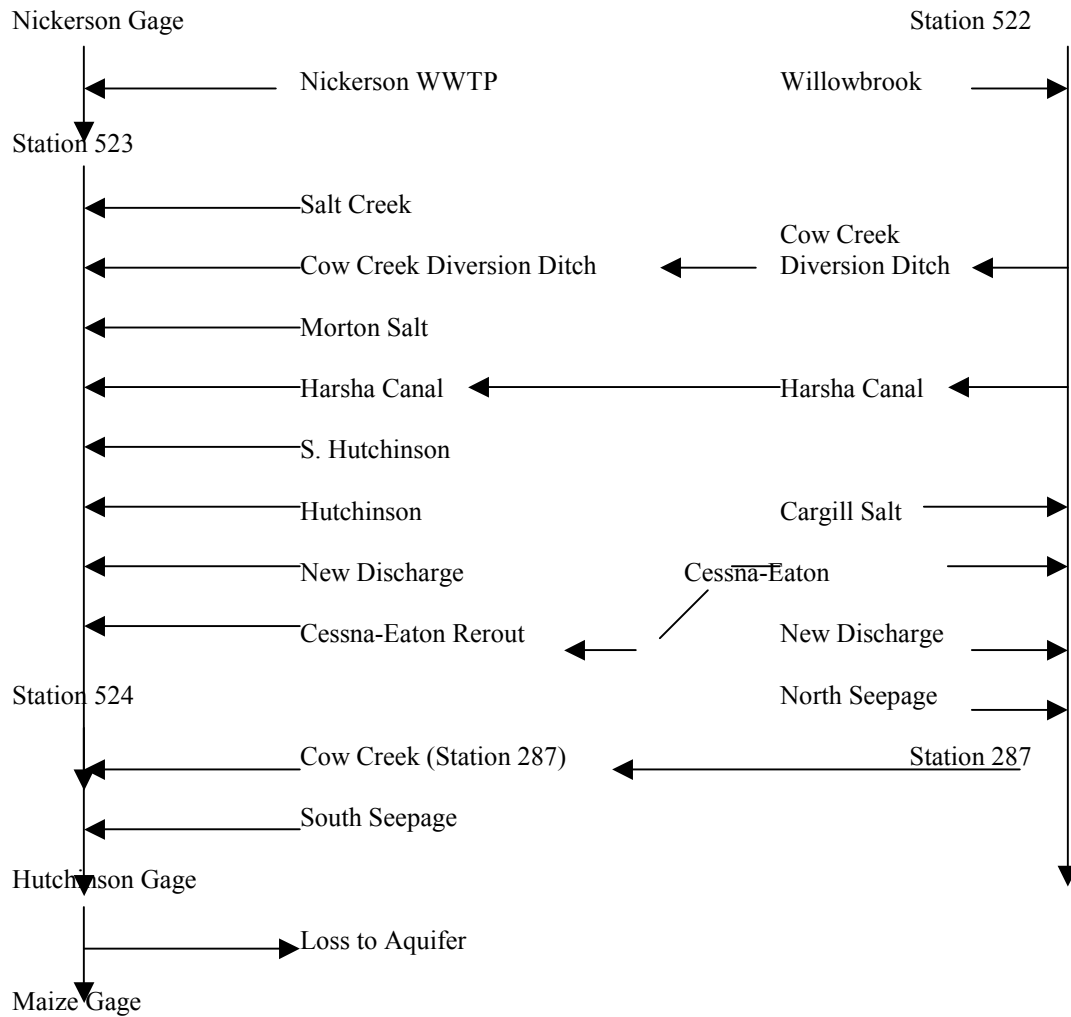
Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Sedgwick County Technical Advisory Group:
Wichita Chamber of Commerce:
City of Hutchinson:
Salt Industry:

Milestone Evaluation: In 2008, evaluation will be made as to the degree of impairment caused by point sources to the streams under low flow conditions and confirmation of the range of background concentrations above Hutchinson. Progress toward chloride reduction should be prepared for implementation by 2010.

Consideration for 303(d) Delisting: The Arkansas River and Lower Cow Creek will be evaluated for delisting from the Section 303d list using the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to applicable criterion during the implementation period, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2004, pending EPA issuing a revised Watershed Rule implementing Section 303d of the Clean Water Act. Implementation plans of this TMDL may be incorporated into a watershed plan for Gar-Peace and Cow Subbasins, pursuant to the Continuing Planning Process. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process after Fiscal Year 2008.

Appendix A-1: Schematic of Arkansas River from Hutchinson to Maize



**APPENDIX A-2 | CALIBRATION
SIMULATION FROM
OCTOBER 1991**

Arkansas River Site	Point Source	WWater Flow cfs	Effluent Conc mg/l	Pollutant Load T/D	Cow Creek Site	Point Source	WWater Flow cfs	Effluent Conc mg/l	Pollutant Load T/D
Nickerson Gage		11.00	542	16.1					
					Station 522 (300 mg/l)		1.00	300	0.8
	Nickerson	0.17	440	0.2		Willowbrook	0.02	630	0.0
					Cow Diversion Ditch		0.10	306	0.1
Station 523 (540 mg/l)		11.17	540	16.3	Harsha Canal		0.92	306	0.8
Salt Creek		0.60	1380	2.2		Cargill Salt	5.30	713	10.2
Cow Diversion Ditch		0.10	306	0.1		Cessna- Eaton	0.00	575	0.0
	Morton Salt	8.30	970	21.7		IMC Salt	5.10	795	10.9
Harsha Canal		0.09	306	0.1	Northern Seepage		1.90	250	1.3
	S. Hutchinson	0.95	735	1.9	Cow Crk Station 287 (650 mg/l)		13.1	652.3	23.1
	Hutchinson	8.50	410	9.4					
Station 524 (645 mg/l)		29.71	645	51.7					
Cow Crk Station 287 (650 mg/l)		13.13	652	23.1					
Southern Seepage		2.00	1000	5.4					
Hutchinson Gage (45 cfs)		44.84	663	80.2					
Aquifer Loss		34.98	663	62.6					
Maize Gage/Station 536 (10 cfs & 660 mg/l)		9.86	663	17.7					

Appendix A-3 | **Base Simulation of Current (2002) Impacts**

Arkansas River Site	Point Source	WWater Flow cfs	Effluent Conc mg/l	Pollutant Load T/D	Cow Creek Site	Point Source	WWater Flow cfs	Effluent Conc mg/l	Pollutant Load T/D
Nickerson Gage		11.00	542	16.1					
					Station 522 (300 mg/l)		1.00	300	0.8
	Nickerson	0.17	440	0.2		Willowbrook	0.02	630	0.0
					Cow Diversion Ditch		0.10	306	0.1
Station 523 (540 mg/l)		11.17	540	16.3	Harsha Canal		0.92	306	0.8
Salt Creek		0.60	1380	2.2		Cargill Salt	6.05	540	8.8
Cow Diversion Ditch		0.10	306	0.1		Cessna-Eaton	2.71	570	4.2
	Morton Salt	8.60	890	20.7		IMC Salt	0.00	795	0.0
Harsha Canal		0.09	306	0.1	Northern Seepage		1.90	250	1.3
	S. Hutchinson	1.08	725	2.1	Cow Crk Station 287 (650 mg/l)		11.5	482.3	15.0
	Hutchinson	8.79	390	9.3					
Station 524 (645 mg/l)		30.43	617	50.7					
Cow Crk Station 287 (650 mg/l)		11.49	482	15.0					
Southern Seepage		2.00	1000	5.4					
Hutchinson Gage (45 cfs)		43.92	599	71.1					
Aquifer Loss		34.26	599	55.4					
Maize Gage/Station		9.66	599	15.6					

